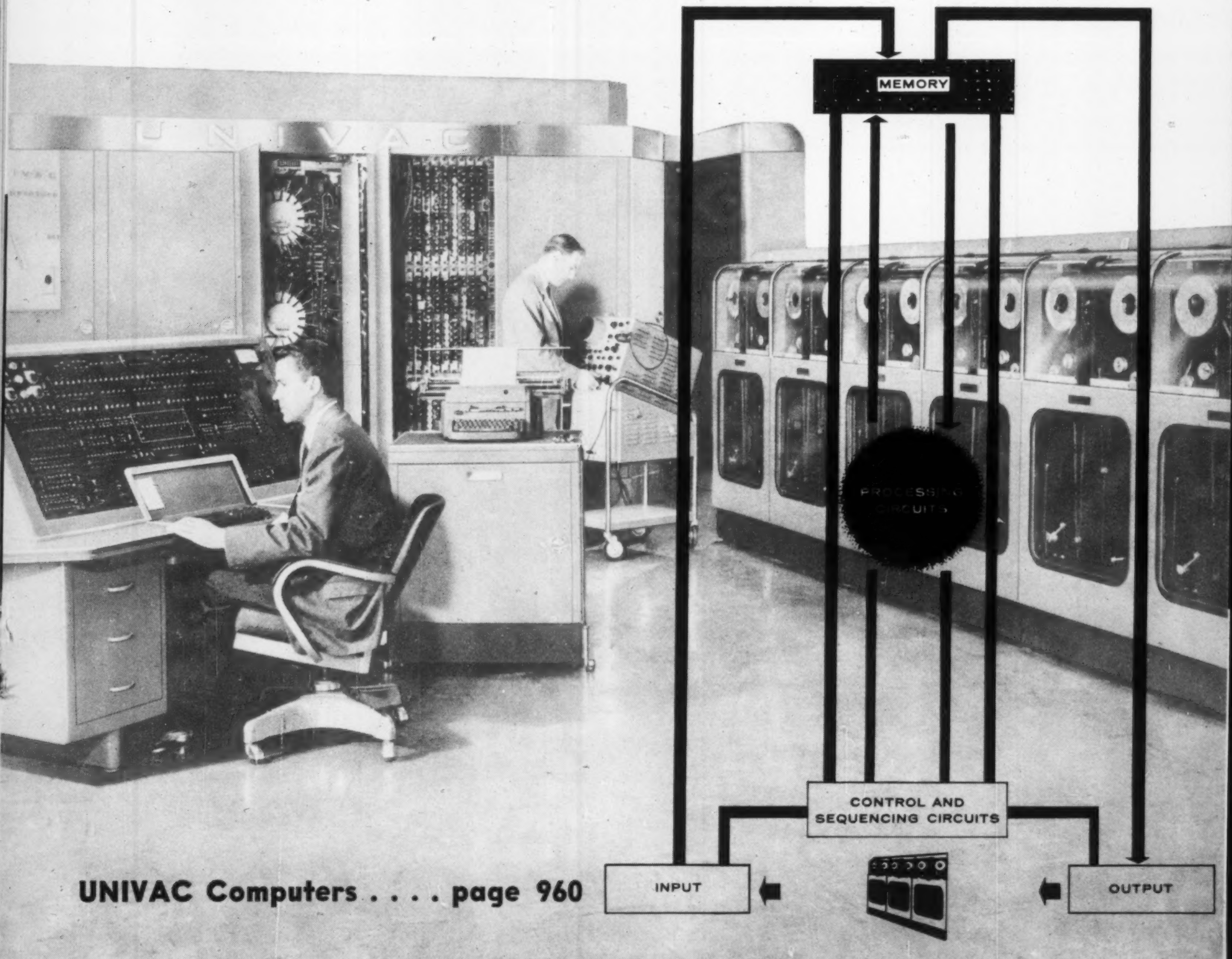
INSTRUMENTS and AUTOMATION


UNIVAC
MEMORY
PROCESSING CIRCUITS
CONTROL AND SEQUENCING CIRCUITS
INPUT
OUTPUT

UNIVAC Computers . . . . page 960

Including: SIMULATION COUNCIL *Newsletter*

and The Journal of the SCMA

Vol. 28, No. 6
JUNE 1955

BS&B
CONTROLS
SIZING
MANUAL
better performance
through accurate
valve sizing...
BLACK, SIVALLS & BRYSON, INC.

NOW!

An Entirely New Method For Sizing Controls!

BS&B's New, Exclusive Method Takes Both The GUESS And The WORK Out Of Controls Sizing For Liquid, Steam And Gas Applications!

Today's modern and complex processing systems require accurate control valve sizing. No one has recognized this fact more than BS&B.

Therefore, as a service to industry, BS&B set out to develop a new, simple, more accurate method of sizing controls. Here it is in the new BS&B Controls Sizing Manual.

This new, exclusive method uses two new "tools" to make sizing more accurate–the SIZE-O-GRAPH to determine what the valve MUST do and Cv RATINGS to determine what the valve WILL do.

These "tools" are based upon thousands of hydraulic flow tests performed on all sizes and types of BS&B Controls in the industry's largest and most modern flow testing laboratory. Results are proven by correlation with *actual* gas and steam flow tests.

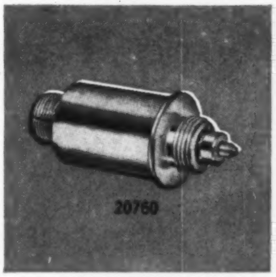
If you'd like a copy of this new manual, write to . . .

EFFICIENCY
OVER 60 YEARS
BS&B
RELIABILITY
ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

BLACK, SIVALLS & BRYSON, INC.

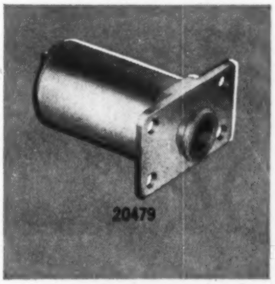
Controls Division, Dept. 4-V6
7500 East 12th Street, Kansas City 26, Missouri

For more information circle 1 on inquiry card.


20760

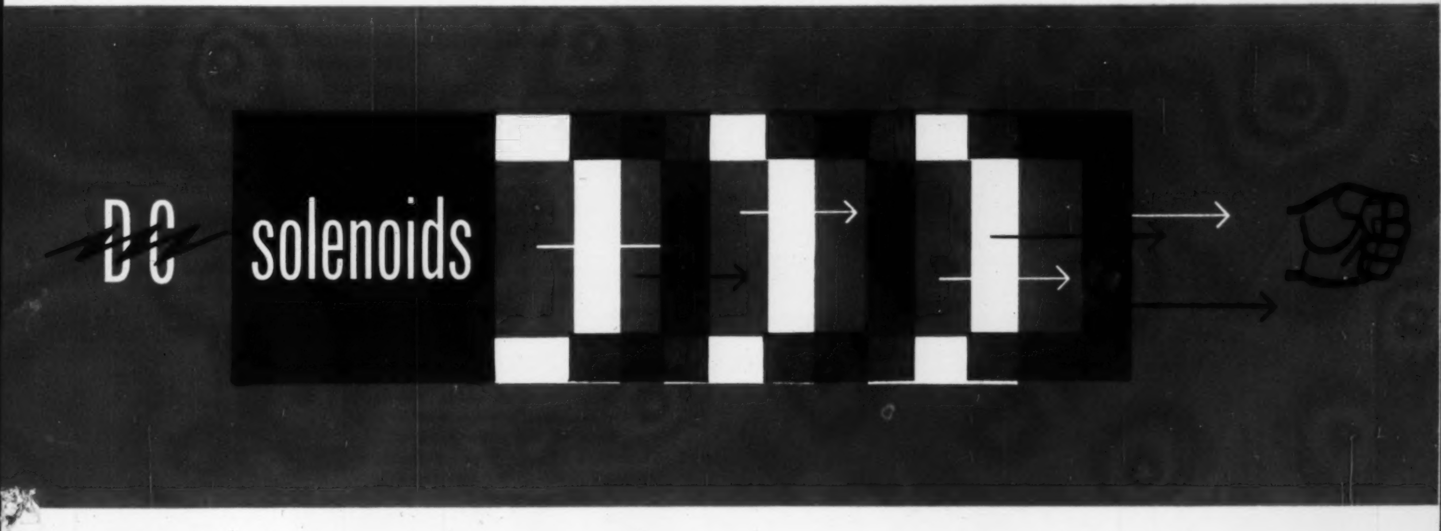
true hermetically sealed solenoids

Just like a sealed vacuum tube! True hermetic sealing around a solenoid . . . glass seal terminals, lugs, and connectors. All welded and brazed construction. Completely plated after assembly. Exceed most requirements of military specification MIL-S-4040 (USAF). Priced at approximately the same level as conventional types.

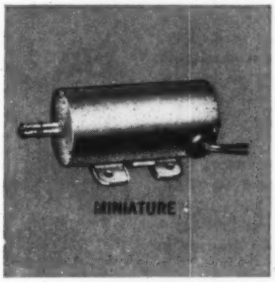

20479

high-temperature solenoids

These modern new solenoids give you a reasonable life expectancy at temperatures as high as 350° C. A by-product of hermetic sealing. Class H insulation combined with inert gas filling add those necessary extra few degrees needed in your temperature limits . . . make these solenoids exceptional high-quality, high-temperature units.

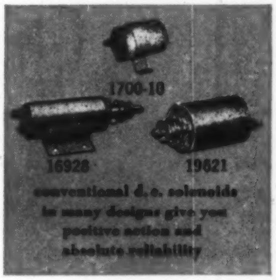


DC solenoids


MINIATURE

. . . and those unusual specialties you look for!

Having trouble finding solenoid specialties? Here at Cannon, we'd like to help you. Standard production now includes multiple-strip solenoids for keyboard operation, locking types requiring no holding current, and miniatures and sub-miniatures ½" diameter. In addition, our expanded solenoid engineering department is ready to serve you at any time.



conventional d. c. solenoids in many designs give you positive action and absolute reliability

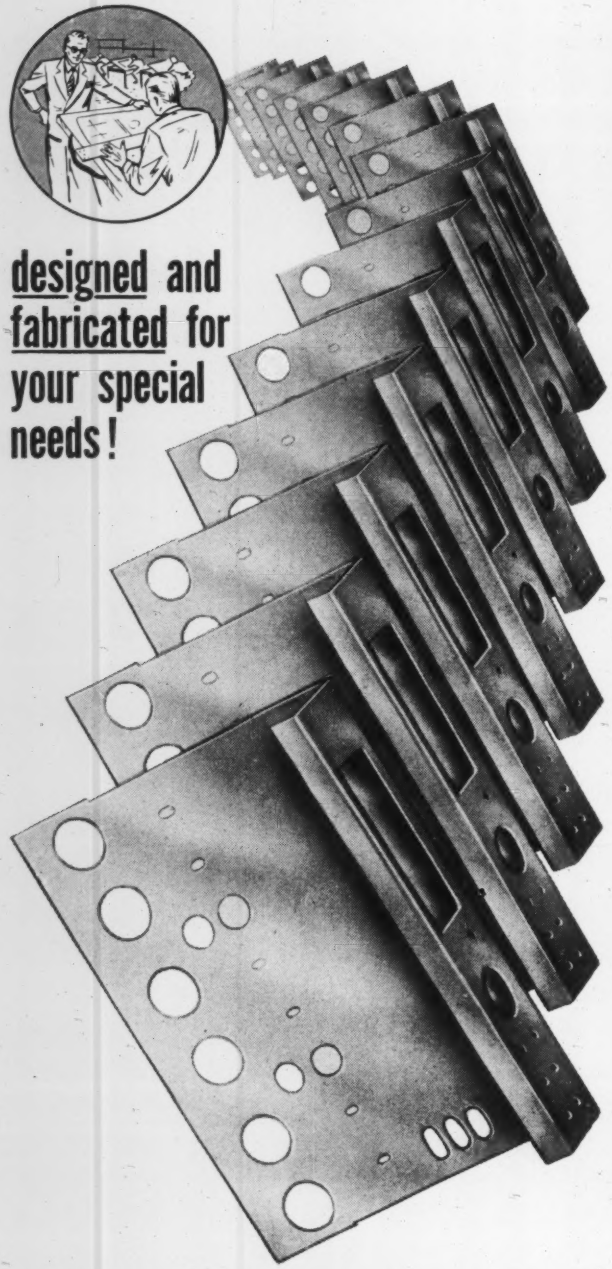
CANNON PLUGS

40th YEAR

CANNON ELECTRIC CO., 3209 Humboldt St., Los Angeles 31, Calif.
Please refer to Dept. 180
Factories in Los Angeles; East Haven; Toronto, Canada; London, England.
Representatives and distributors in all principal cities

Please ask for latest SR-S releases and/or Solenoid Bulletin.

For more information circle **2** on inquiry card.



designed and fabricated for your special needs!

FALSTROM—custom metal fabricators since 1870—offer America's most up-to-date facilities for the manufacture of large or small parts in sheet steel, aluminum, copper, brass and other alloys to closest tolerances . . . on long or short runs. A to Z fabrication under one roof is another advantage that saves you costs and avoids delays.

FALSTROM makes all kinds of instrument panels, graphic panels, cabinets, chassis, cubicles, consoles and metal fabricated parts for all industrial purposes. Consult Falstrom for custom contract manufacturing at practical unit cost. Send us your blueprints for quotation or ask about our standard designs. **Write for Bulletin 143-A.**

Falstrom means it's that much better!

FALSTROM CO.

92 Falstrom Court • Passaic, New Jersey

For more information circle **3** on inquiry card.

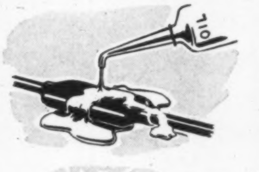
Partners in Production

Joy Electrical Connectors
and
Automatic Controls

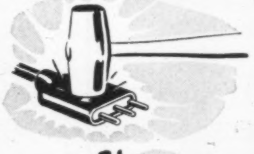
What happens to Automation . . . when electrical connectors fail?

No automatic control system yet devised will keep machines running when an electrical plug or receptacle in their power feeder line or power control circuit *poops out.* That's why JOY's one-piece molded Neoprene connectors deserve your careful consideration. Factory wired and permanently molded to cord or cable, they provide many extra advantages that add up to a long life of dependable service under the most adverse operating conditions. (A few are listed below.) Available in a wide variety of designs with 1 through 16 contacts for 150 to 600 volt applications. **Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.** In Canada: *Joy Manufacturing Co. (Canada) Limited, Galt, Ontario.*

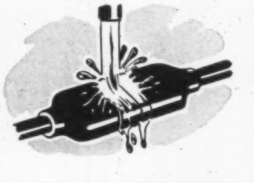
Oil-Sealed . . .
One-piece molded cable connector assembly protects conductors from oil and other external impurities. Face rings protect contacts from similar contamination, when connectors are engaged.



Distortion-Proof . . .
Factory molded as trim one-piece synthetic rubber jacketed units, JOY connectors cannot crack, will not shatter and are practically impossible to knock out of shape.



Moisture-Tight
JOY electrical connectors are absolutely moisture-tight from wiring juncture to face . . . and when connected even their contacts are protectively encased in a resilient housing.



JOY
INDUSTRY

Free . . .
New Bulletin —
Ask for No. B59

CD 355.2

JOY

SOURCE OF INDUSTRY'S FAVORITE ELECTRICAL CONNECTORS SINCE '28

For more information circle **4** on inquiry card.

RESTRAINING SPRING

Contents...

INSTRUMENTS
and
AUTOMATION

Vol. 28, No. 6 June 1955

Richard Rimbach, Publisher
Milton H. Aronson, Editor
Manoel F. Behar, Editor Emeritus
James Emge, Associate Editor
David S. Aland, Associate Editor
Milo D. Pugh, Western Editor
John H. McLeod, Jr., Associate Editor (Simulation Council Newsletter)
Armand T. Gaudreau, Consulting Editor (Automation)

District Offices and Managers

Altadena, Calif., Milo D. Pugh & Associates: M. D. Pugh, 2721 N. Marengo Ave., SYcamore 7-2894; Hunter Vinton, 1050 Lincoln Ave., Palo Alto, Calif., Davenport 5-4815

Boston 16, Mass., Harold H. Short, Jr., Holt Road, Andover, Mass., Andover 2212

Chicago 1, Ill., Harold W. Haskett, Room 1205, 228 N. La Salle St., Central 6-8963

Cincinnati 5, Ohio, Harold W. Haskett, 742 Elberon Ave., Grandview 4323

Dallas, Texas, Edward F. Wright, 505 N. Ervay, Rm. 310. Prospect 0189

Kansas City 6, Missouri, Thomas W. Wright, 18 East 11th St., Telephone BAltimore 7305

New York 17, N. Y., Richard Rimbach, Jr., 525 Lexington Ave., Rm. 359, Murray Hill 8-0980

Philadelphia, Pa., Robert H. Maxwell, 7 Wilde Ave., Drexel Hill, Pa., Clearbrook 9-4342 (Phila. Suburban)

Pittsburgh 12, Pa., C. Goldcamp, 845 Ridge Ave., Fairfax 1-0161

St. Louis 1, Mo., Stephen E. Wright, 706 Chestnut St., Chestnut 1-1965

London. W.1, England, John C. N. Hughes, Crown House, 143-147 Regent St., Regent 3891

SUBSCRIPTION RATES
For One, Two, and Three Years

	One Year	Two Years	Three Years
United States, U.S. Possessions and Canada	$4.00	$7.00	$ 9.00
Latin America and Australia	5.00	8.00	12.00
Belgium, Denmark, France, Great Britain, Holland, Italy, Norway, Portugal, Spain, Sweden, Switzerland and West Germany	6.00	10.00	15.00
Austria, Bulgaria, China, Czechoslovakia, East Germany, Hungary, India, Poland, Romania, Russia and Yugoslavia	10.00	16.00	24.00

MEMBER

Audit Bureau of Circulation.

Payments from outside the U. S. A. must be in the form of an International Money Order or check on a U. S. Bank.

Position and company connection as well as products manufactured must be indicated in all subscription orders.

Editorial

Automation and Economics—A Counterattack on Anti-automation Propaganda 893

Feature Articles

Process Control Analysis 957
by Millard H. LaJoy and E. Allen Baillif

UNIVAC and UNIVAC SCIENTIFIC 960
by William Allen and Graham E. Smith

Air Traffic Control—A Growing Problem 970
by F. B. Lee

Electronic Circuitry 972
by Charles F. Kezer and Milton H. Aronson

Instrumentation of A Modern Steam-Generating Facility 974
by J. P. Katzenmeyer

Problems of A New Soaking-Pit Installation 982
by A. F. Robbins and H. Meek

Nuclear Power Developments 986
by W. Kennth Davis

The Simulation Council Newsletter 951

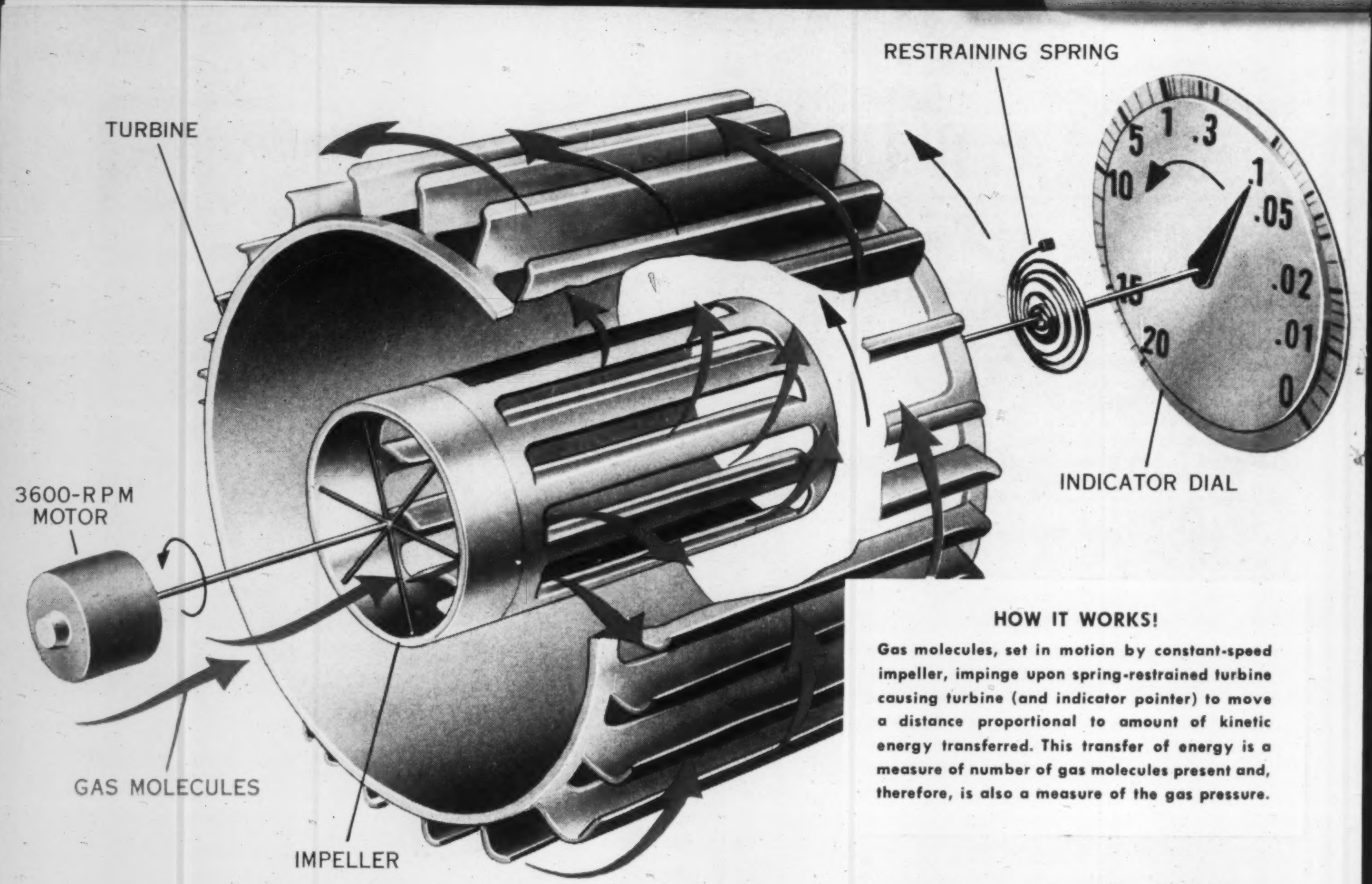
Journal of the Southern California Meter Association

Why A Relief Valve? 988
by Joseph Conison

Other Regular Features

Trends 859
Stock Report 861
News 873
Events Calendar 880
New Instruments 898
Test Your I.Q. 949
Briefs 992
New Literature 1000
Searchlite Section 1014
Advertisers' Index 1017
Inquiry Card 1017

Copyright 1955, published monthly, by The Instruments Publishing Company, Inc. Office of publication, 1600 North Main Street, Pontiac, Illinois. Executive and Editorial Office, 845 Ridge Avenue, Pittsburgh 12, Pennsylvania. Entered as second class matter January 26, 1932, at the post office at Pittsburgh under the Act of March 3, 1879. Transferred permit October 14, 1949 to the post office at Pontiac, Illinois, under the act of March 3, 1879.



HOW IT WORKS!

Gas molecules, set in motion by constant-speed impeller, impinge upon spring-restrained turbine causing turbine (and indicator pointer) to move a distance proportional to amount of kinetic energy transferred. This transfer of energy is a measure of number of gas molecules present and, therefore, is also a measure of the gas pressure.

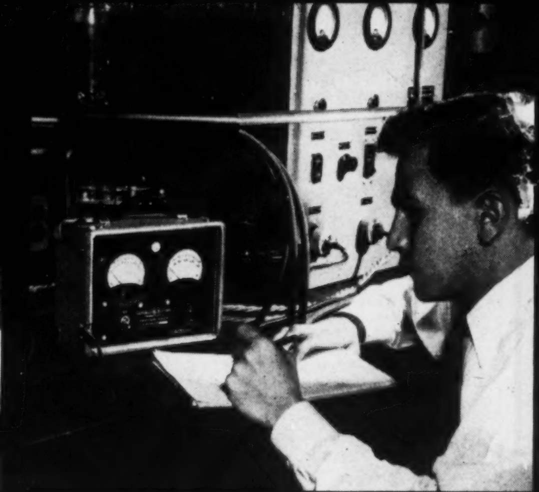
HIGHLY VERSATILE, the new G-E molecular vacuum gage is supplied with a scale for the direct reading of dry air (between 0 and 20 millimeters), or with a linear scale which may be easily calibrated for other gases. The device is therefore well suited for laboratory and research work in the fields of vacuum metallurgy and metal purification, outgassing of impregnates, distillation of low-boiling compounds, vacuum coating and plating, dehydration of heat-sensitive materials, and vacuum extraction and solvent recovery.

News About Other General Electric Equipment for Vacuum Systems

DETECTS FROM 1 TO 10^{-5} MICRONS

ION VACUUM GAGE is easy to use and does not require continuous adjustment of the filament voltage supply. For longer life, the filament is automatically protected against excessive pressures. Price is $614.64*.

DETECTS FROM 1 TO 100 MICRONS



THERMOCOUPLE VACUUM GAGE eliminates the need for permanent test panels, lowers investment costs. This G-E instrument provides continuous, remote indication. The price is only $109.98*.

**Manufacturer's suggested retail price.*

For more information circle **5** on inquiry card.

WITH THE G-E MOLECULAR VACUUM GAGE . . .

Measure Vacuum Without External Detectors

GENERAL ELECTRIC GAGE IS DIRECT READING FROM 1 TO 20,000 MICRONS

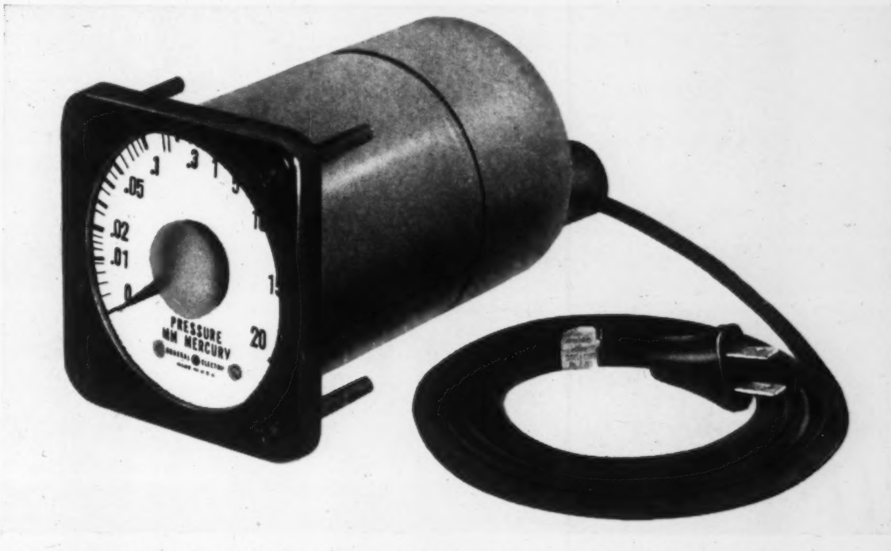
Because of its entirely new principle of operation, General Electric's molecular vacuum gage eliminates the need for external detectors. Now, you can measure pressure from 1 to 20,000 microns quicker and easier than ever before.

LOW IN COST, the G-E gage sells for only $195.00*. No other device costing as little offers the wide range and simplicity of operation provided by the molecular vacuum gage.

TUBE BURNOUTS ARE ELIMINATED because of the revolutionary new principle of operation used. The G-E gage is entirely mechanical. No electronic tubes or other electrical detecting devices are used.

UNHARMED BY ATMOSPHERIC PRESSURE, the molecular vacuum gage may be opened without fear of damage to the mechanism. This feature is particularly valuable when semi-skilled personnel use the instrument.

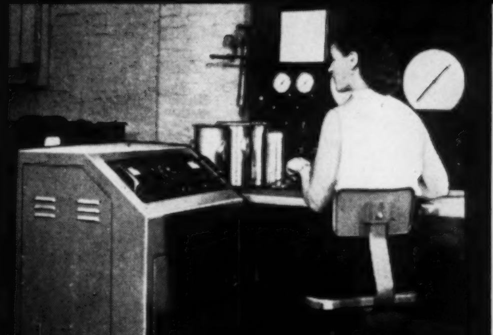
FURTHER INFORMATION may be obtained by contacting your nearest G-E Apparatus Sales Office or check the coupon below for a copy of bulletin GEC-986.



EASY-TO-OPERATE, the molecular vacuum gage requires no complicated setting of control knobs. Direct-reading, the instrument calibration remains unaltered through continuous operation. The long scale span in the high-vacuum range, and the highly legible numerals of the indicator dial assure accurate readings. Face-plate studs facilitate panel mounting or the gage may be connected directly to the vacuum system plumbing.

EXTREMELY SENSITIVE LEAK DETECTION

GENERAL ELECTRIC



SECTION B-585-3
GENERAL ELECTRIC COMPANY
SCHENECTADY 5, N. Y.

Please send me the following bulletins:

- ☐ **Molecular Vacuum Gage (GEC-986)**
- ☐ **Ion Gage (HB-8282)**
- ☐ **Thermocouple Vacuum Gage (GEC-385)**
- ☐ **Type M-1 Leak Detector (GEC-336)**

Name..

Company ....

Street..

City.................... **Zone** .... **State**..............

G-E LEAK DETECTOR can detect a leak in vacuum or pressure systems at the rate of 5 x 10^{-7} standard cubic centimeters of air per second. Simple design of control panel makes this an easy instrument to operate. Compact mass spectrometer unit can detect leaks so small that more than 120 years would elapse before a thimble-full of air at atmospheric pressure could escape. Write for details.

GENERAL ELECTRIC

For more information circle **5** on inquiry card.

Flight test bottleneck?

Here's a tailor-made way out...

CEC's new DataTape

If data reduction is slowing down your development program, here's good news. Consolidated Engineering . . . world leader in flight-test instrumentation . . . now brings you "DataTape," a really new magnetic-tape recording system. Designed specifically for data recording, DataTape is ideal for engineering flight testing . . . *because it was designed that way right from the drawing board.*

DataTape flight-test data can be scanned and evaluated automatically . . . yields *reduced* data in a fraction of the time needed for manual reduction of oscillograph records. Playback equipment can be tied directly to digitizing equipment . . . such as CEC's MilliSADIC . . . and thence to digital computers, if desired, for virtual elimination of the human factor in data processing. It's an ideal way out of one of modern aviation's most serious bottlenecks . . . engineering data reduction.

RECORDER

Data Channels . . . 12 or 24 standard, plus 1 flutter-control track and 1 time or voice track per 12 data channels.

Tape Speeds . . . 10, 20 and 40 in/sec; or 7½, 15 and 30 in/sec.

Recording Time . . . 43 minutes at 10 in/sec; 57 minutes at 7½ in/sec.

Flutter . . . less than 0.2% peak to peak (0.08% rms) over 5 to 300 cps band @ 10 in/sec. Mechanical flutter compensation on playback reduces this figure to 0.1% peak to peak (0.04% rms) in 0 to 20 cps range; electronic system compensates for flutter at higher frequencies.

Power . . . 115 volts, single-phase, 50/60/400 cps; 275 watts.

Size . . . 7 x 22 x 11¾"; 60 pounds.

Controls, indicators . . . all on top plate. Warning lamps indicate data loss from mechanical or electronic failure.

RECORDER

RECORD AMPLIFIER*

Channels . . . 14 or 28, including flutter-control, range-time and voice-recording tracks.

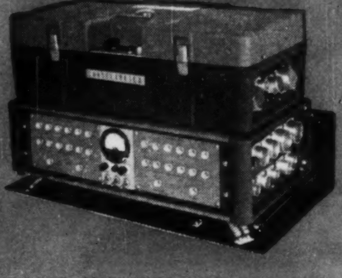
Frequency response . . . without modulators, flat ±1.6 db 300 to 18,000 cps @ 10 in/sec and 300 to 36,000 cps @ 20 in/sec; flat ±2.3 db 300 to 60,000 cps @ 40 in/sec.

Signal Input . . . 0.50 volts full scale; channel input impedance to attentuator 100,000 ohms.

Power . . . 115 volts, single-phase, 50/60/400 cps; 225 watts.

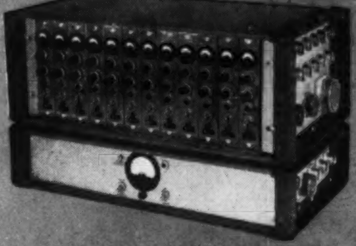
Size . . . 5⅞ x 22 x 11¾"; 35 pounds.

*Unit contains own data-channel amplifiers, power supply, bias and flutter-control oscillators, and microphone amplifier.



RECORD AMPLIFIER AND RECORDER

For more information circle **6** on inquiry card.

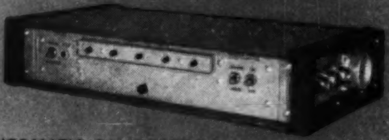

SIGNAL MODULATOR

SIGNAL MODULATOR

Contains up to 12 plug-in modulators per case for amplifying and "coding" signal input voltages to a form adapted to precision magnetic-tape recording. Each channel accommodates either: (a) direct-recording input unit, (b) combination compound-modulation/frequency-modulation (CM/FM) modulator or (c) pulse-duration modulator (PDM). Separate power supply provides all voltages for 12 modulators plus AM carrier for CM recording.

Power . . . 115 volts, single-phase, 50/60/400 cps; 250 watts.

Size . . . (a) 12-channel modulator case: 7⅝ x 22 x 11¾"; 53 pounds.
(b) power supply: 4⅛ x 22 x 11¾"; 50 pounds.


AUTOMATIC CALIBRATOR

AUTOMATIC CALIBRATOR

Provides "in-flight" calibration for both bridge-type and self-generating transducers and for thermocouples. Signals supplied to 12 data channels simultaneously; two units used for 24-channel system. Zero check plus two positive and two negative calibration values provided for bridges and thermocouples; zero check and two amplitude levels for vibration pickups. Calibration of 12 channels completed in one second under automatic cycling control. Manual control permits calibration at chosen periods.

Power . . . 115 volts, single-phase, 50/60/400 cps; 75 watts.

Size . . . 4¼ x 22 x 11¾"; 45 pounds.

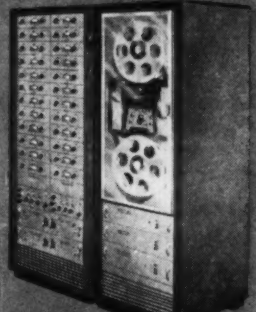
RANGE-TIME GENERATOR

RANGE-TIME GENERATOR

Provides visual display of tuning-fork-controlled time at the recording equipment and at the remote control station. Also provides binary-coded-decimal time signal for recording on the magnetic tape and for use as a master time signal to control or operate counters, solenoids, etc. Slightly over 27 hours . . . 99,999 seconds . . . can be accumulated and indicated.

Power . . . 115 volts, single-phase, 50/60/400 cps; 100 watts.

Size . . . 4¼ x 22 x 11¾"; 35 pounds.


PLAYBACK EQUIPMENT

PLAYBACK EQUIPMENT

Standard rack-mounted playback equipment can be operated in the laboratory or trailer-mounted for field use. One cabinet houses tape-transport assembly and equalizing preamplifiers. (Servo-operated flutter-correction equipment available for compensated playback.) Second cabinet houses demodulation electronics for recovering original signals. Interchangeable demodulators, matched to the modulation technique used in recording, may be inserted into each channel drawer. Resulting signals can drive galvanometers, oscilloscopes, chart recorders . . . or automatic digital-conversion devices, such as the CEC MilliSADIC.

Power . . . 2400 watts for typical 24 data-channel system.

Consolidated's experienced Field Engineers and its Systems Division are ready now to show how Data-Tape can serve you. Write today to Pasadena or to any CEC local office for Bulletin CEC 1561-X4

Consolidated Engineering
Corporation

ELECTRONIC INSTRUMENTS FOR MEASUREMENT AND CONTROL

300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service Offices Located in: *Albuquerque, Atlanta, Boston, Buffalo, Chicago, Dallas, Detroit, New York, Pasadena, Philadelphia, San Francisco, Seattle, Washington, D. C.*

For more information circle **6** on inquiry card.

the INSTRUMENTS and ELECTRONICS traveling show

Manufacturers of instruments, automation and electronic devices can display in 30 cities—at a cost of less than $200 per city!

Now, for the first time, the instrument industry will have a means for reaching individuals never before contacted at the national, stationary trade shows.

The Show will move by a specially designed van; thorough and complete show management throughout its travel will be furnished by Richard Rimbach Associates.

Physical requirements will limit participation to 45 exhibit booths. Your prompt reply will guarantee inclusion in The 1956 Instruments and Electronics Traveling Show.

OVER 30 CITIES COAST TO COAST WILL BE ON THE ITINERARY

Write to Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Pa., or telephone FAirfax 1-9831

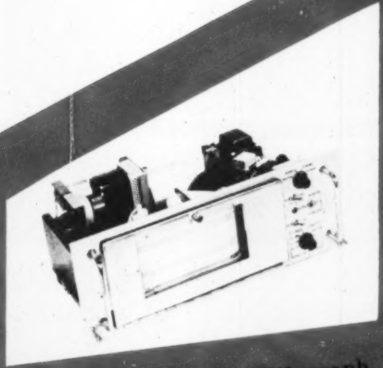
Circle **8** on inquiry card →

Another Brush First!

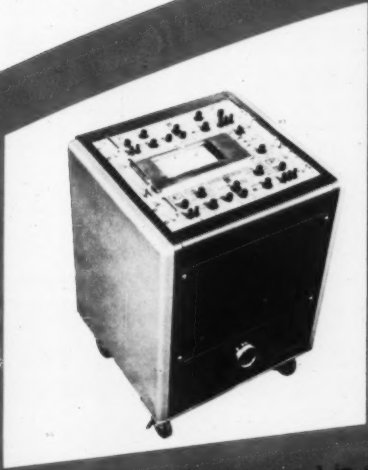
NEW 1- AND 2-CHANNEL OSCILLOGRAPHS RECORD AT 8 OR 16 SPEEDS!

Now for the first time, you have a choice of 16 recording speeds in single and dual-channel direct writing oscillographs. The chart drive is electrically-controlled, permitting speed to be changed instantaneously from either local or remote locations. The chart drive system is highly accurate, providing a linear time base at all speeds. You can select the lowest speed that gives desired resolution of signal with economy of paper.

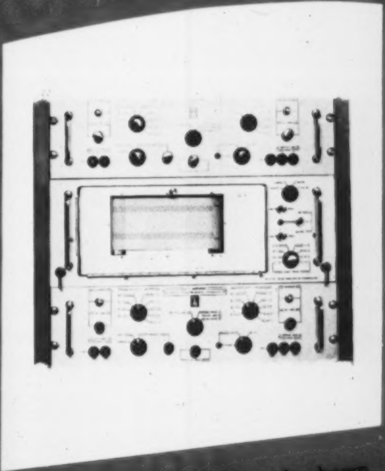
When used with Brush Amplifiers, these oscillographs give you an extended frequency response from d.c. to 100 cps. The same basic unit can be obtained for either single or dual-channel recording; you have a choice of ink or combination ink and electric writing.



New Dual-Channel Oscillograph Model BL-262 provides internal chart take up; time and event markers can be mounted.



Oscillographs can be mounted in a mobile instrument cart or used on a test bench. Oscillograph has 7" x 19" panel, 10½" overall depth.



Dual-Channel Oscillograph shown rack mounted; also available in Single-Channel (Model BL-261).

Brush now offers a complete series of 1, 2, 4, or 6-channel Recording Systems. They can simplify your testing and analysis, save valuable engineering time. Send coupon for complete information.

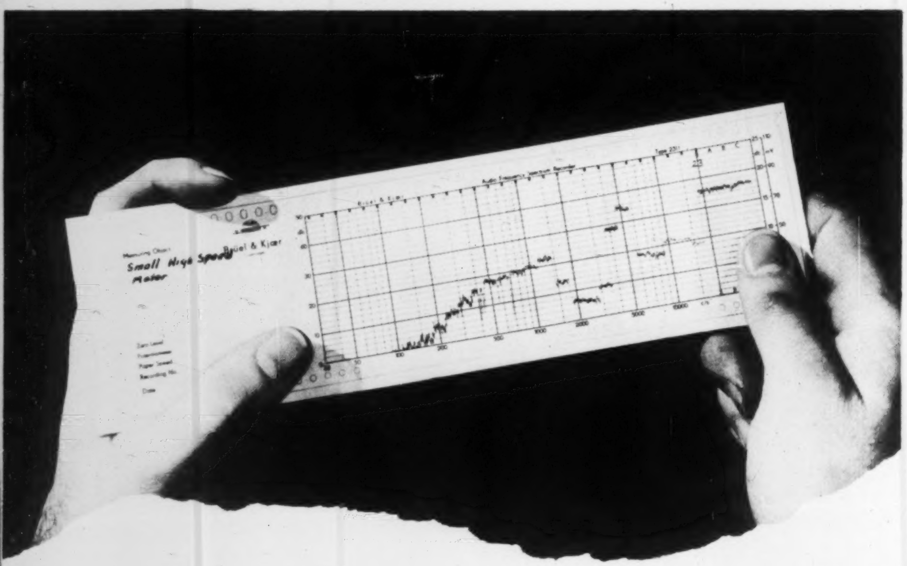
SEND COUPON →

BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZOELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT AND COMPONENTS

Division of Clevite Corporation

Sound Measurement



BRUSH INSTRUMENTS RECORD FREQUENCY-AMPLITUDE DATA; SIMPLIFY SOUND ANALYSIS

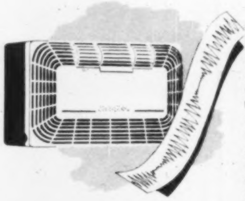
This chart record was produced by the Brush Third-Octave Spectrum Recorder. It presents a complete frequency and noise level analysis for an electric motor, showing noise levels in each one-third octave band from 35 cycles to 18,000 cycles per second. This chart is typical of the graphic presentation of either complete frequency analysis or frequency response measurement data. The Third-Octave Spectrum Recorder can operate unattended for 24 hours or more, to record all sounds in noise control programs.

Brush offers a completely integrated line of precision equipment, developed by Bruel & Kjaer, for analysis of sound, noise, vibration. These versatile instruments can also be used in data reduction, or recording of electrical quantities. Send coupon for complete information.

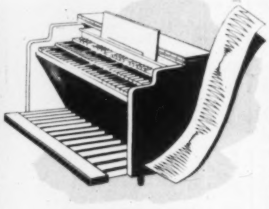
BRUSH ELECTRONICS COMPANY, Dept. 66
3405 Perkins Avenue, Cleveland 14, Ohio

☐ Send booklet on new single and dual-channel oscillographs.
☐ Send booklet on "Sound Measurements".
☐ Have representative call.

Name ______________________________
Title ______________________________
Company ______________________________
Address ______________________________
City ______________________ *State* ________



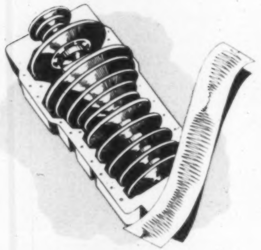
CARRIER CORPORATION . . . uses Spectrum Recorder for production quality control checks of noise levels of room air conditioning units. In 30 seconds, the instrument automatically checks the cooler throughout the eight octaves of audible sound.



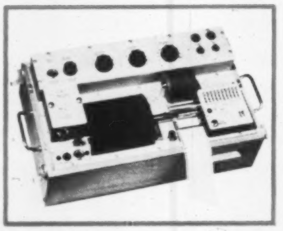
HAMMOND ORGAN . . . uses Frequency Response Recorder to test ringing time of tone generating circuits. This instrument combines a test signal source and a graphic recorder for automatically plotting frequency response curves.

BELTONE . . . uses Frequency Response Recorder to perform entire frequency and sensitivity measurements on high-quality hearing aids.

LOCKHEED . . . uses Spectrum Analyzer in a non-audio application — for data reduction of telemetered information. Instrument records data after magnetic tape playback, with band pass filters isolating each frequency band.



GENERAL ELECTRIC . . . uses Frequency Response Recorder to check mechanical resonance points of turbine blades for both steam and jet turbines. Instrument plots frequency against amplitude when blades are magnetically vibrated.



High Speed Level Recorder is the basic instrument in the Bruel & Kjaer line. Used in conjunction with other equipment for recording acoustic or electro-acoustic measurements.

One-Third Octave Spectrum Recorder consists of Spectrum Analyzer and Level Recorder. Self-contained system for noise analysis and recording.

BRUSH ELECTRONICS COMPANY

BRUSH ELECTRONICS

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZOELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT AND COMPONENTS

Division of Clevite Corporation

Better Records

FOXBORO
FOXBORO
GEN'L PURPOSE
INK

BETTER CHARTS

Humitex Charts printed from high-precision plates, under controlled humidity conditions, on special, high-stability paper. Easy-to-read gray printing against chart's smooth, white background brings out full brilliance of new Foxboro Ink.

BETTER PENS

Non-corroding, stainless-steel pens with positive capillary feed. Controlled special-process points (standard and fine line) assure sharper, cleaner records.

BETTER INK

Five rich, brilliant colors . . . won't clog or "feather" . . . sediment-free . . . flows smoothly under all atmospheric conditions. Specially formulated for new Foxboro Pens and Charts.

NEW INK DISPENSER

Exclusive-design, easy-to-handle polyethylene "squeeze" dispenser (pat. pend.) gives pin-point control of drop size, ends messy pen-filling. Won't leak or break.

THE FOXBORO COMPANY
466 NEPONSET AVE., FOXBORO, MASS., U.S.A.

FOXBORO FOR BETTER RECORDS
REG. U. S. PAT. OFF.

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

For more information circle 9 on inquiry card.

← Circle 8 on inquiry card.

LEWIS

RESISTANCE THERMOMETER AND ACCESSORIES

The Model 62 RT4F Resistance Thermometer is a sturdy, easy to read instrument with a six inch hand drawn scale. It is suitable for use in moving vehicles, is excellent for flight testing or for permanent panel installations. Operated by an ordinary dry cell and calibrated to standard "AN" bulb curves, this instrument is ideal for use with any of the resistance bulbs illustrated below. Other ranges available in °C or °F.

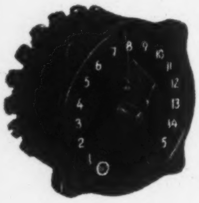
-60
-50
-40
-30
-20
-10
0
10
20
30
40
CENTIGRADE
CH.
USE RES. BULB NO. 56B
THE LEWIS ENG. CO.
NAUGATUCK, CONN.
ON
CH.
OFF
MODEL NO. 62RT4F

ACCESSORIES — RESISTANCE BULBS AND SWITCHES

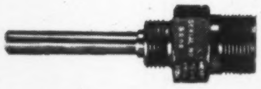
Lewis Selector Switches have been used for years in automotive test work as well as in permanent installations. Simple, sturdy construction plus finest materials combine to give long service.

2" SIZE TO 4 POINTS

FREE AIR



3" SIZE TO 20 POINTS



THREADED "AN" TYPE

4" SIZE TO 28 POINTS

THREADED "AN" TYPE

BAYONET TYPE FOR CYLINDER HEAD TEMPERATURE

Lewis Resistance Bulbs are adaptable for use with the 62RT4F Resistance Thermometer or with standard aircraft panel indicators. Special purpose bulbs with stem variations or for high temperature applications are available.

We invite inquiries on your temperature measuring problems.

THE LEWIS ENGINEERING CO.

Manufacturers of *Complete* Temperature Measuring Systems for Aircraft
NAUGATUCK, CONNECTICUT

For more information circle **10** on inquiry card.

Trends...

INSTRUMENTS
and
AUTOMATION

Air traffic control is growing problem (see page 970). Number of fix postings (position reports of enroute traffic) was 8.5 million in 1948; 11.8 million in 1951; 16.8 million in 1954—and is expected to reach 24 million by 1960, 28 million by 1965. Look for increased use of Instrument Landing Systems, radar, traffic control simulators, and traffic data computers. Airline industry revenue will exceed $1 billion in 1955 (was $350 million in 1947, $880 million in 1953). CAA air traffic control towers handled 17.9 million aircraft movements in 1954 (16.8 million in 1953).

Industrial plant maintenance bill has risen from $5 billion in 1950 to $10 billion in 1954, according to GE estimate—and will be $11 billion in 1955, with increase due largely to automation.

Use of permanent magnets is increasing in industry. Uses include removing iron from pipeline products, plating tanks, hydraulic system reservoirs, molding sand, etc.; also for conveying and controlling parts and products during manufacturing; also for separating sheets of stacked materials.

Railroad communications is expanding field. Yard operations are becoming more automatic; remote control signal systems permit greater use of tracks; train crews can be reached by short-wave radio; operations research is being applied to traffic and yard problems.

Power generating capacity of the United States doubled in the decade 1945-1954 from 50 to 100 million kw. W. K. Davis of AEC (see page 986) estimates twofold expansion (to 200 million kw) by 1965, another twofold expansion (to 400 million kw) by 1975. By 1975, 25% of generating capacity may be nuclear in nature. This will expand nuclear-instrument field.

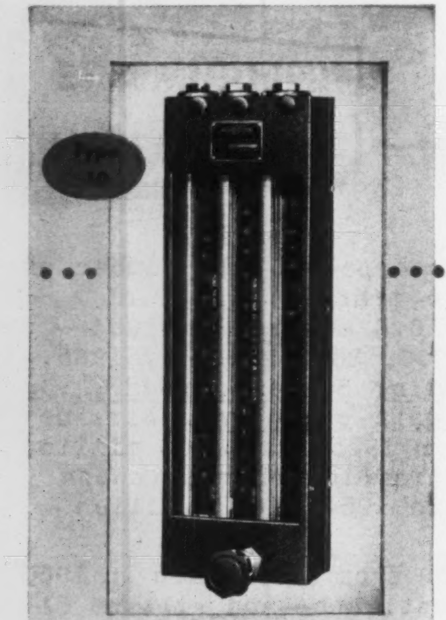
Electronics industry total volume in 1955 is expected to exceed $9 billion—50% military, 25% communications, 20% industrial, 5% replacement. D. G. Mitchell of Sylvania predicts $15 billion annual gross by 1960, $20 billion by 1964.

Air-pollution instrumentation is expanding. Philadelphia's $6.5 million civic waste removal program includes 15 refuse furnaces with automatic electronic combustion control system (designed by M-H). Refineries in LA area alone have spent more than $25 million on smog problem.

High-pressure instrumentation is expanding. Chemical-industry pilot-plant operations are underway at 100,000 psi; laboratory chemical operations are moving into the 200,000-psi range.

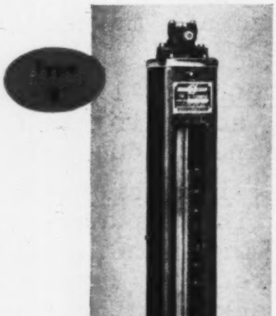
Simulation technique is capturing attention of industrial control engineers. Inclusion of Simulation Council Newsletter in Instruments & Automation is bringing computer and industrial fields together. Process engineers now want to know how to get the constants out of their equipment. Control manufacturers must supply some of the answers; other data must come from within the plant. Watch for new developments in this field, which can change entire approach to operating instrumentation.

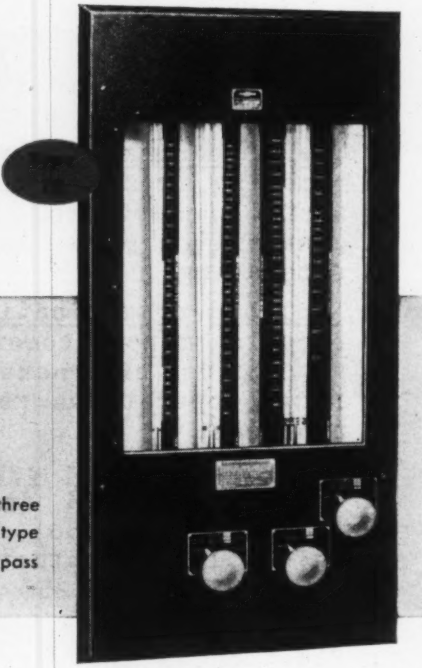
DO YOU USE FLOWMETERS FOR LABORATORY RESEARCH OR PRODUCTION?



... .COX FLOWMETERS

are designed for flow rate measurement of fuels (such as gasoline, kerosene, diesel and jet fuel) and of many liquids and gases. They are built for use in the laboratory, in a wide range of production processes, or for a combination of the two.





→ **For the Laboratory:** *Type 10 Multiple Stage Flowmeters,* designed as a compact laboratory instrument for precise measurement of smaller fluid flow rates.

→ **For Production:** *Type 8 Single Stage Flowmeters,* engineered for a maximum flow capacity of 50,000 pounds per hour.

→ **For Both:** *Type 12 Multiple Stage Flowmeters,* available in three series — the 40, the 90, and the 100 Each has logarithmic type scales for excellent readability and can be equipped with a bypass orifice to greatly increase flow capacity.

● Individually graduated scales; patented "Inner Wall" guides that insure perfect float centering within the metering tube; and extra-sensitive floats are a few of the major features of Cox Flowmeters. Scales are graduated for a specific fluid. Scales for metering other fluids can be easily interchanged. Multiple Stage Flowmeters are available for wide flow ranges, and bypass orifices can be built in which greatly increase the flow capacities without increasing panel space required.

The Type 12, 40 Series Flowmeter, available in single and multiple-stage units, is firmly established as the most accurate variable-area flowmeter now made. Each individually graduated logarithmic scale is accurate to within ±½ percent of the actual flow at any point on the scale. It is readable to within ±¼ percent of indicated flow at any point.

Look for Other CRL *Products*

- AIR FLOWMETERS
- CARBURETOR FLOW STANDS
- ENGINE INDICATORS
- FLOWMETER CALIBRATING STANDS
- FUEL NOZZLE TEST STANDS
- MAGNETIC THICKNESS GAGES
- VIBRATION RECORDING EQUIPMENT
- BALANCED ELECTRONIC EQUIPMENT FOR PRESSURE AND VIBRATIONS

Commercial Research Laboratories, Inc.

20 BARTLETT AVENUE • DETROIT 3, MICHIGAN

U. S. PATENTS 2,384,800
2,309,957
2,403,849
2,417,352

Makers of REGISTERED TRADE MARK ***Since 1912***

For more information circle **11** on inquiry card.

Stock Report . . . . INSTRUMENTS and AUTOMATION

FINANCIAL adviser services are asking their clients to observe and consider the stocks of automation firms in terms of long-range growth prospects. In the March, 1955 issue of *Instruments and Automation* a report on various firms in the automation field was published. This report, prepared by the well-known firm of Bache & Co., 36 Wall Street, New York 6, N. Y., elicited immediate interest in many diverse areas. We will continue to keep our readers posted on this data.

The following prices and price ranges are supplied by Bache & Co., 36 Wall Street, New York 5, New York

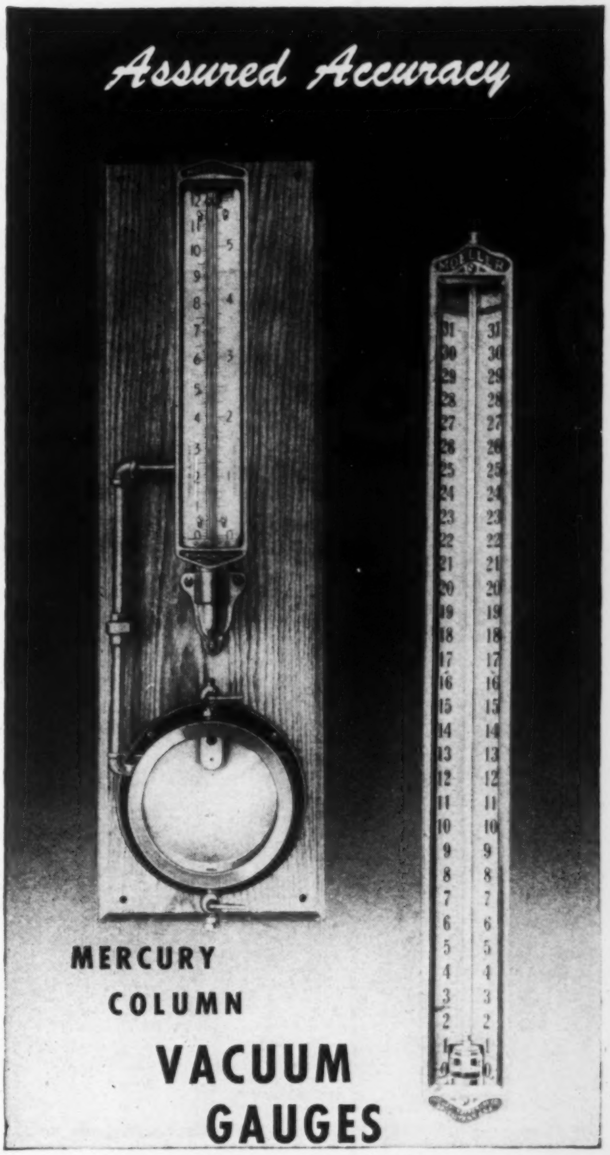
New York Stock Exchange:

	1955 Price Range (thru March 31)		March/55 Price Range		
	High	Low	High	Low	Last 3/31/55
American C. & C.	40 1/2	35 1/2	39 3/4	37	37
American Mach. & F.	33 3/4	25	33 3/4	28	32 1/2
American Mach. & M.	41 3/8	27 1/2	41 3/8	31 1/2	39
American Optical	53 1/4	39 1/8	53 1/4	44 1/2	47 7/8
Bell & Howell	37 1/4	30 1/2	37 1/4	31 1/2	35 1/4
Bendix Aviation [1]	59 1/2	52 1/2	59 1/2	52 1/2	56 3/4
Bulova Watch	62 1/2	50 3/4	58	52 3/8	56 5/8
Burroughs	31 5/8	22 7/8	31 5/8	27 1/2	29 1/8
Clevite	25 3/8	20 3/4	24 1/8	20 3/4	22 1/2
Daystrom	32 1/2	23	32 1/2	26 1/4	29 1/2
Dobeckmun	36	30 1/4	34 5/8	30 1/4	31 1/2
Gamewell	39	32 1/2	35 1/4	33	34 3/4
General Inst.	13	10	12 3/8	10 3/8	12
General Prec.	65 1/2	44 5/8	65 1/2	56	63 7/8
General Time	39 3/4	35	39 3/8	36 1/2	36 1/2
Hamilton Watch	25 1/4	20	24 3/4	22 5/8	24 3/4
Int. Bus. Mach.	404	349	404	368	397
Jaeger Machine	34 3/4	27 3/8	31 7/8	28 5/8	30 1/8
Minneapolis-Hon.	118	96 1/8	118	106 3/4	108 1/2
Nat'l Cash Reg. [2]	47	37	44 5/8	39 1/2	44
Radio Corp.	45 1/4	36 3/4	45	38 3/4	42 1/8
Raytheon	25 1/4	18	25 1/4	19 3/8	24 1/8
Rem. Rand	48 5/8	31 1/4	48 5/8	39	40 7/8
Robertshaw-F.	32 7/8	28	31 7/8	28	30 1/8
Sangamo Electric	30 3/8	26	29 3/4	26	28 7/8
Sperry Corp. [3]	65 3/8	39 3/4	65 3/8	45	63 3/4
Square D	48 3/4	43 1/2	48	43 5/8	46 1/2
L. S. Starrett	50	43 1/2	46 3/4	43 1/2	44
Sylvania Elec.	47 3/8	41	47 1/4	41	43 1/4
Telautograph	35 1/2	25 1/2	35 1/2	31	33 1/4
Texas Inst.	16 7/8	12 5/8	15 7/8	13 1/4	15 3/8
Underwood	38	33 3/8	36 7/8	33 3/8	35 1/4
Weston Elec. Inst.	30 1/4	24 3/4	30 1/4	27 1/2	29 1/2

American Stock Exchange:

	1955 Price Range (thru March 31)		March/55 Price Range		
	High	Low	High	Low	Last 3/31/55
Aeroquip Corp.	17 1/2	8 1/2	17 1/2	13 1/2	15 7/8
Air Assoc.	12 3/4	10 1/4	11 1/4	10 1/4	10 1/8-11 [4]
American Meter	35	32 5/8	35	33	33 1/4-34 [4]
Beckman Inst.	26 7/8	21 3/4	25	21 3/4	22 7/8
Benrus Watch	10 7/8	10	10 5/8	10	10 1/4
Breeze Corp.	8 5/8	5 3/4	8 3/8	6 3/4	8
Clarostat Mfg.	8	5 7/8	8	6 3/8	7 1/2
Consol. Eng.	31 1/4	24 3/4	31	24 3/4	27
DuMont Labs.	17 1/8	13 1/4	17 1/8	14 5/8	14 5/8
ElectroData	17 3/4	12	17 3/4	14 7/8	16
Fairchild C. & I.	37 1/4	31 1/2	36 1/4	31 1/2	32
Int'l Resistance	8	5	8	7	7 7/8
Lear, Inc.	13 3/8	9 1/8	12 1/2	10 3/8	11 5/8
Nat'l Res. Corp.	33 1/4	26	28 7/8	26	28 1/4
Neptune Meter	26 3/8	21	26 3/8	22 1/2	24 1/2
New Haven Clock	3 1/2	2 5/8	2 7/8	2 5/8	2 5/8
Norden-Ketay	19 1/2	14 3/4	18 5/8	15 1/2	17 5/8
Pneumatic Scale	29 1/8	27 1/2	29 1/8	28 5/8	28 3/4-29 1/2 [4]
Servomechanisms	13 3/8	11 1/8	13 1/8	11 1/8	11 5/8
Wallace & Tiernan	26 7/8	22 3/8	25	22 3/8	23 1/8
Waltham Watch	2 7/8	1 3/8	2 3/4	1 7/8	2

1. Qts. are for 'new' stk. Common split 2 for 1. New shares admitted to W 1 trading on 3/1/55.
2. 2 for 1 split.
3. Stock to be split
4. Bid - ask price, no sale.



Engineered to perfection for use in the plant and testing laboratory with complete assurance. A tribute that comes from the constant use and the widespread recognition of Moeller's achievements in design, durability and precision.

MOELLER INSTRUMENT COMPANY
132nd STREET & 89th AVENUE, RICHMOND HILL 18, NEW YORK, N.Y., U.S.A.

Gentlemen: Without obligation, please send me Catalog No. 150 on Moeller Mercury Column Vacuum Gauges.

NAME ....

FIRM ....

ADDRESS ....

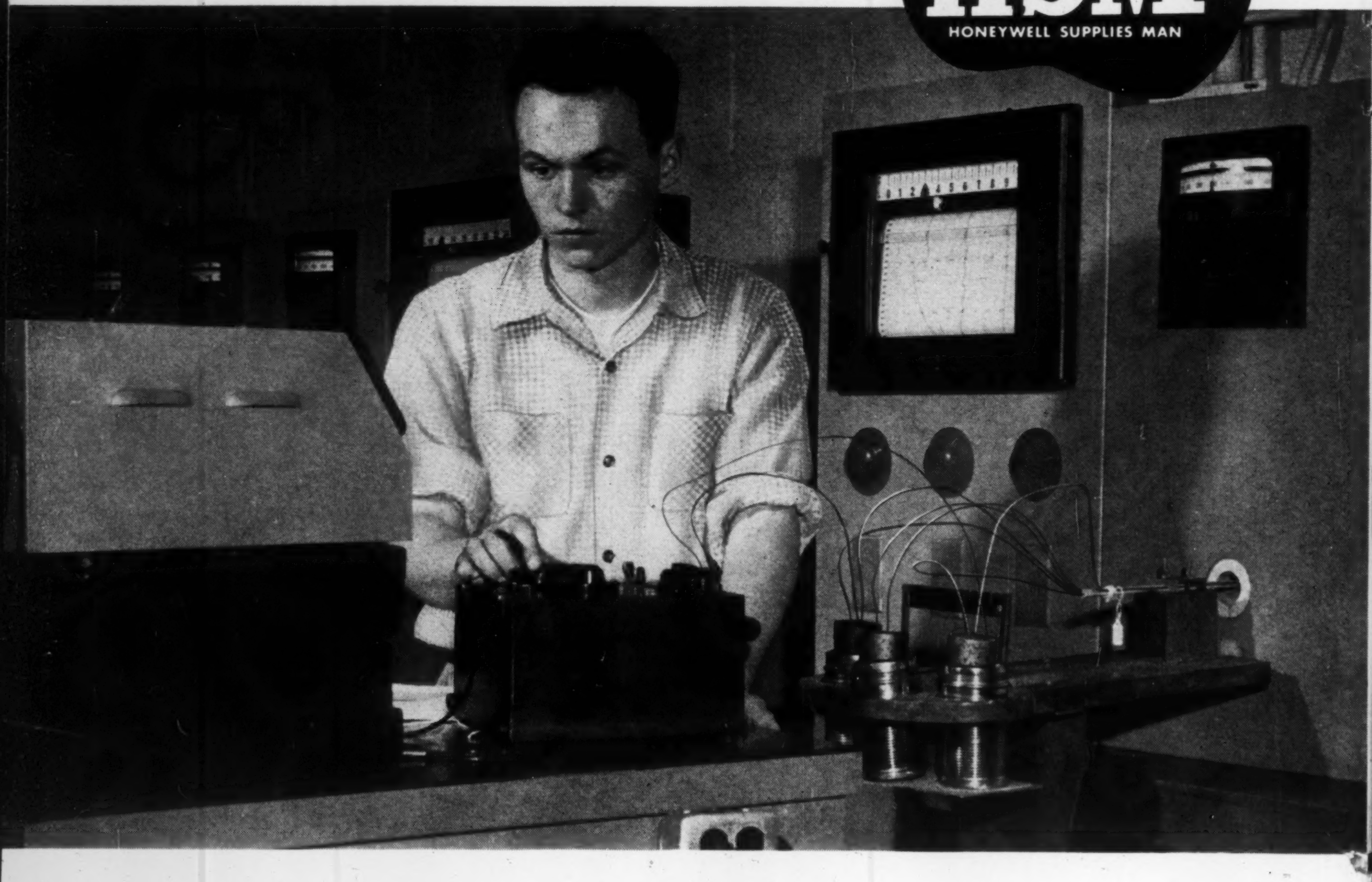
CITY .... ZONE .... STATE ....

For more information circle 12 on inquiry card.

Lab-tested thermocouple wire *available through your*

HSM

HONEYWELL SUPPLIES MAN



CONNECT a thermocouple with only ± 1% accuracy to an instrument with accuracy of ± ¼% . . . and how closely can you measure? The answer is simple. Overall accuracy *can't* be any better than your thermocouple.

To guarantee you consistent accuracy in your temperature detecting elements, Honeywell maintains a fully equipped wire checking laboratory. Here every spool of thermocouple or extension wire is tested against standard wires that have been certified by the National Bureau of Standards. Checks are made at numerous points throughout the temperature range of the calibration in which the wire will be used. Every spool of wire meets rigid standards before it is accepted. Calibration figures are tagged on each spool.

The result of this laboratory control is that every order of Brown thermocouple or extension wire you receive can be counted on to deliver identical standards of high precision.

Ask your Honeywell Supplies Man to give you complete facts about Brown thermocouple and extension wires . . . and to tell you how the HSM Plan can bring you new convenience and economy in all your purchasing of pyrometer supplies. Call him today at your local Honeywell office . . . as near to you as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

- **REFERENCE DATA:**
Write for Pyrometer Supplies Buyers' Guide No. 100-6.

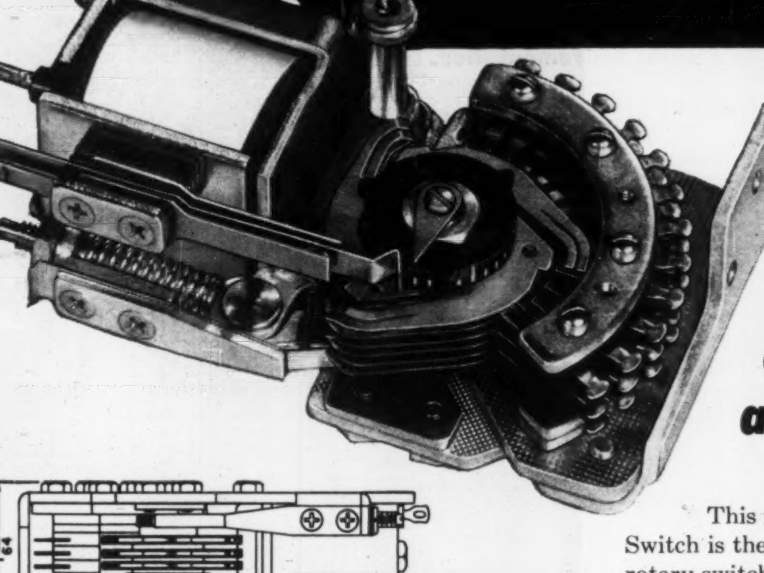
H
HONEYWELL

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

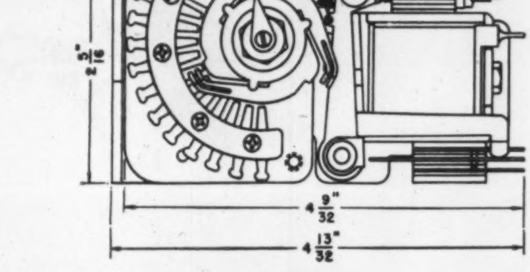
For more information circle **13** on inquiry card.

Available NOW!

New CLARE Type 11 Springdriven Stepping Switch



Small, compact design provides millions of steps without any readjustment



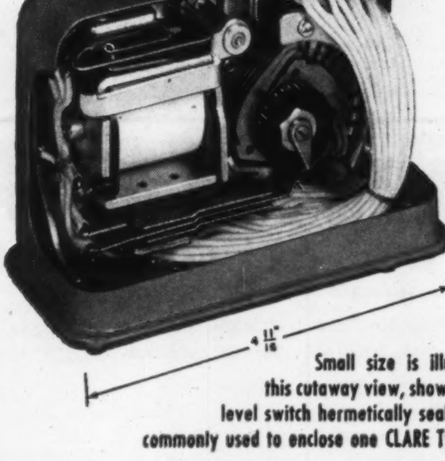
This new CLARE Type 11 Springdriven Stepping Switch is the latest in the CLARE line of uniselectors, or rotary switches, for completing, interrupting, or changing the connections in a succession of electric circuits in response to momentary impulses of current.

Like the larger and older switches in the CLARE line—Types 20, 26, 40 and 52—this sturdy, fast-stepping little switch is capable of many different applications, such as:

- *Selecting any desired point in a series*
- *Selecting the first unoccupied point in a series*
- *Sequence controlling: automatically controlling a series of operations in a predetermined manner*
- *Counting and totalizing*
- *Generating timed pulses*
- *Monitoring*

The CLARE Type 11 Switch is designed to be free from critical adjustments. The few adjustment points are unusually easy to reach when required, but choice of materials and design provides millions of steps without any readjustment.

Send for Engineering Bulletin No. 121 for complete information on the new CLARE Type 11. Address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Ill. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address: CLARELAY.



Small size is illustrated by this cutaway view, showing a three-level switch hermetically sealed in a can commonly used to enclose one CLARE Type C Relay

FIRST in the industrial field **CLARE RELAYS**

For more information circle **14** on inquiry card.

Operation of Plant-Scale Installations*
DEMONSTRATES BENEFITS OF ELECTRONIC PROCESS CONTROL

'American-Microsen' Electronic Process Control Installations Now In Successful Operation Have Proved The Reliability, Speed, Sensitivity And Accuracy Of This Modern Concept Of Process Instrumentation.

This is the electronic process control system that now makes it practicable to utilize the capabilities of process equipment far more fully than ever before. Revealed in actual operation of plant-scale installations are the much discussed benefits of this new approach to plant instrumentation.

Used to *measure, indicate, record and control process variables* (pressure, differential pressure, temperature, level flow, pH, gas analysis, etc.), these installations exhibit every essential to improve product quality, increase operational efficiency and plant productivity.

Only the 'American-Microsen' System provides:

Lag-free signal transmission using the simplest communication lines.

Extremely fast, accurate measurements and control responses — sensitivity impossible to duplicate in other types.

Installation of all controllers in the instrument room *any distance from the process* — even 30 miles or more.

High stability that permits use of narrower proportional bands.

Freedom from dirt, leakage, freeze-ups and other transmission line problems.

Standardized control components interchangeable at the panel and plug-in components on each instrument.

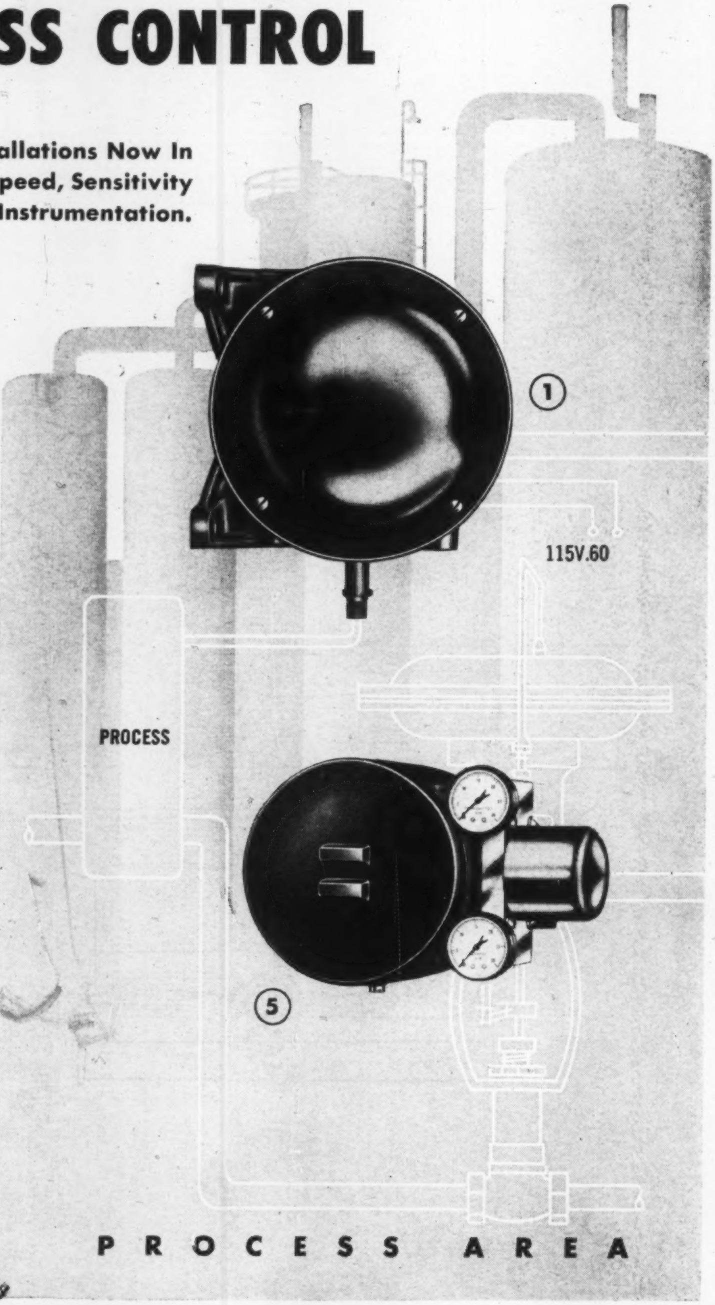
Adaptability — more than one input circuit can be fed into a controller for cascading or programming.

DC signal that can be fed to potentiometer recorders, digital read-out systems, monitors, computers, etc., so that process and operational data are automatically reduced to quickly usable form.

Flexibility — output signal can be fed in series to any number of receivers, without impairing accuracy. Components can be mounted anywhere convenient to operating and servicing.

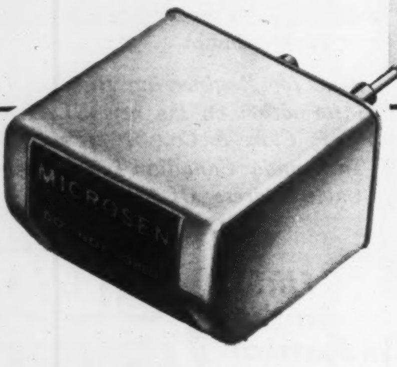
Electrical circuitry makes possible unusual control and measurement functions not available in mechanical systems.

Minimum installation or maintenance investment in transmission lines, air compressors, filters, pressure regulators, dryers.



MANNING,

**Names and locations of installations available upon request.*

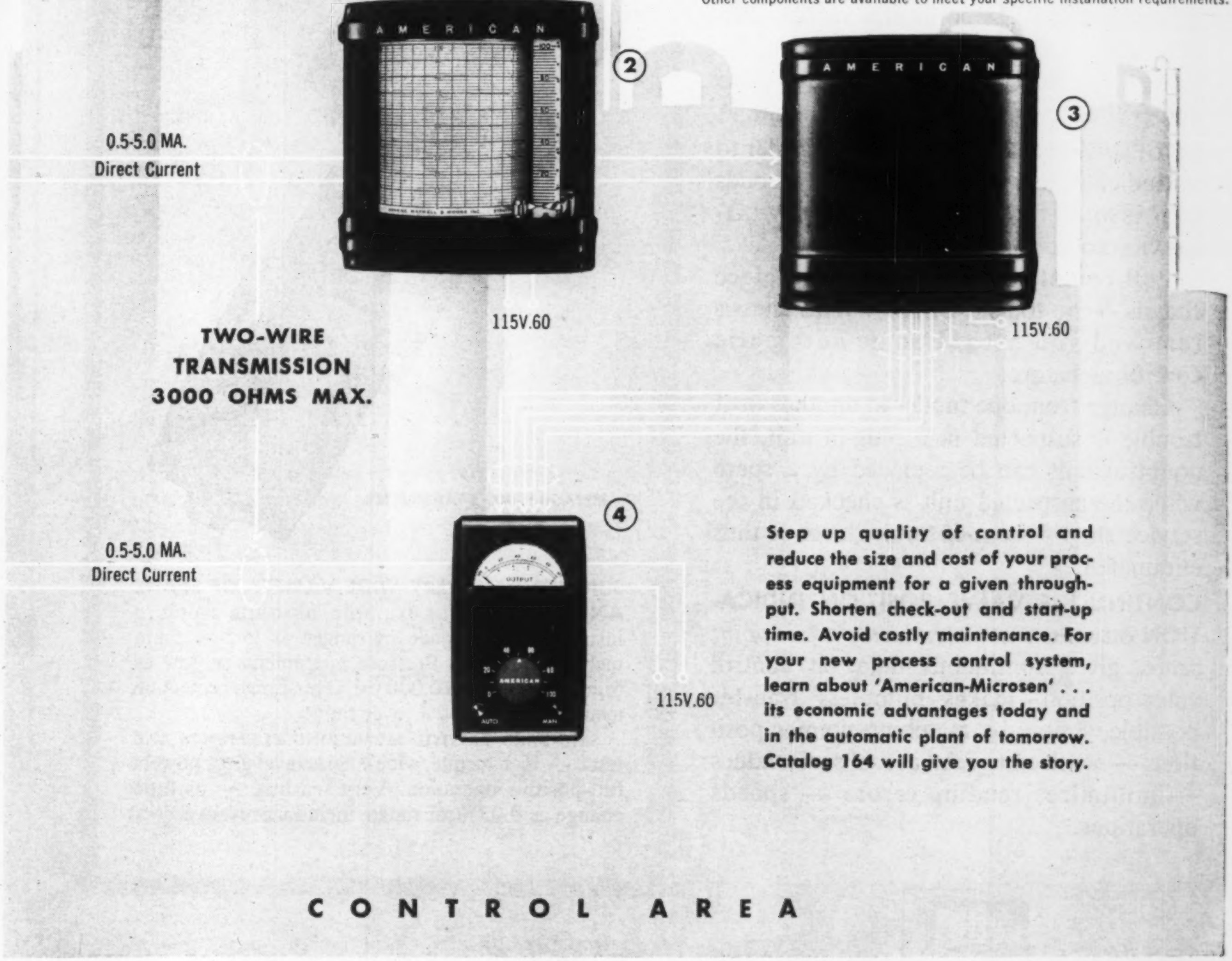


THE 'MICROSEN' BALANCE, the "nerve center" of 'American-Microsen' Instruments, is a simple, electro-mechanical servomechanism. It operates on the force-balance principle to produce a high-level direct current signal that is not affected by any normal electrical or ambient condition.

For more information circle **15** on inquiry card.

1. **TRANSMITTER.** Types to transmit measurements of temperature, pressure, differential pressure, liquid level, flow, pH, oxygen concentration, gas analysis, etc.
2. **RECORDING SET STATION.** Records on strip chart or card and compares the measured variable with the control point setting. Error signal is transmitted to the Controller.
3. **CONTROLLER.** An electronic amplifier with simple feedback circuits to produce calibrated proportional, reset and rate control actions. (Rate action added by plug-in unit.) Resulting control signal is fed to the Manual Control Station.
4. **MANUAL CONTROL STATION.** Permits switching from automatic to manual valve operation during start-up or emergency conditions. Bumpless transfer from manual back to automatic operation is built into the instrument. Retransmits control signal to Electro-Pneumatic Valve Positioner.
5. **ELECTRO-PNEUMATIC VALVE POSITIONER.** Mountable on all standard pneumatically-powered valves. Transduces the signal to pneumatic pressure up to 25 psi to operate the valve with position feedback.

Other components are available to meet your specific installation requirements.



Step up quality of control and reduce the size and cost of your process equipment for a given throughput. Shorten check-out and start-up time. Avoid costly maintenance. For your new process control system, learn about 'American-Microsen' . . . its economic advantages today and in the automatic plant of tomorrow. Catalog 164 will give you the story.

MAXWELL & MOORE

INCORPORATED

INDUSTRIAL CONTROLS DIVISION

Stratford, Connecticut

MAKERS OF 'AMERICAN-MICROSEN' ELECTRONIC TRANSMITTERS, INDICATING OR RECORDING SET STATIONS, CONTROLLERS, MANUAL CONTROL STATIONS AND ELECTRO-PNEUMATIC VALVE POSITIONERS.

For more information circle **15** on inquiry card.

WHAT'S NEW AT BRISTOL

FIRST instrument system BASIC GRAPHIC-PANEL

It's BRISTOL'S new metagraphic instrument system

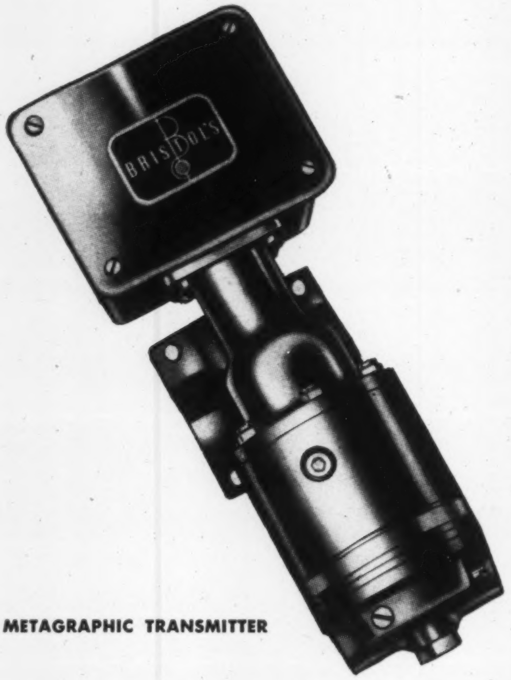
A WIDE SELECTION: For example, there are 35 receiver and 34 controller models and the widest variety of transmitters on the market. A model can be found among these that will exactly meet any requirement.

FULL PLUG-IN SERVICE: Change recorder to an indicator or vice versa in 10 seconds with ABSOLUTELY NO INTERRUPTION WHATSOEVER TO AUTOMATIC CONTROL.

Pull complete chassis out (one piece chassis — no tools required). With chassis removed you get the same automatic control as before.

Change from one model to another or if trouble is suspected in a plug-in unit, the doubtful unit can be replaced by a spare while the suspected unit is checked in the service shop — out-of-service time is thus eliminated.

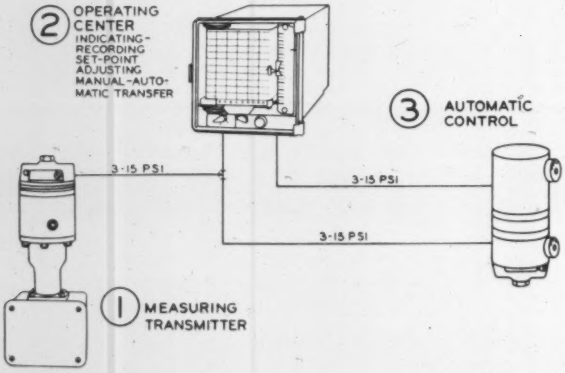
CONTINUOUS VALVE POSITION INDICATION on *same instrument scale as set point scale*, gives continuous data on control valve position – makes "bumpless" transfer possible, simply by matching pointer positions — no need to read actual scale values — minimizes reading errors — speeds operations.



METAGRAPHIC TRANSMITTER

SUPPLIED IN A VERY WIDE VARIETY OF SPANS AND RANGES: For example, absolute pressure instruments are made in ranges as low as 5mm mercury absolute. Pressure instruments as low as 5 inches water to 10,000 psi. Over-range protection available up to 400% over range.

STANDARD BRISTOL MEASURING ELEMENTS ARE USED — high torque, wide-angle travel gives powerful, positive operation. Very sensitive — as little change as 0.03% of range, including reversal.

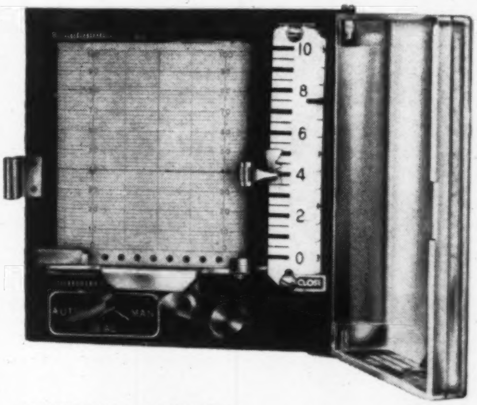


METAGRAPHIC INSTRUMENTS MEASURE, RECORD, INDICATE, AND AUTOMATICALLY CONTROL

- Pressure
- Vacuum
- Absolute Pressure
- Differential Pressure
- Liquid Level
- Flow
- Temperature and Mechanical Motion

For more information circle **16** on inquiry card.

that carries out idea completely!

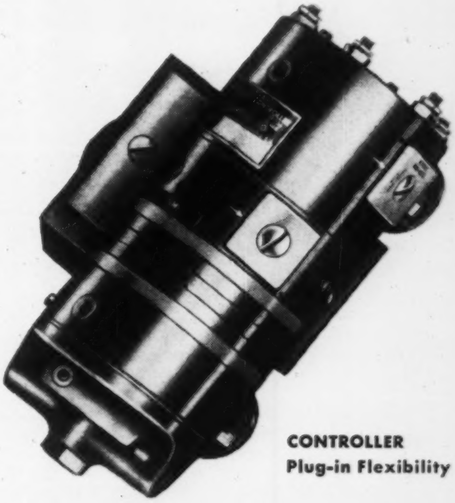


RECORDING RECEIVER:
Also furnished as an Indicator

NO INTERRUPTION WHATEVER TO AUTOMATIC CONTROL when receiver chassis is removed. The chassis of a Metagraphic Receiver is plug-in construction and can be changed from a recorder to an indicator or back in a matter of 10 seconds.

OFFERED FOR UP TO 3 MEASURED VARIABLES — with air pressure regulators or air-loaded regulators — three-position manual-automatic transfer valves for automatic control and *six-position (on the same knob) transfer valves for cascaded control.*

ALL MEASUREMENTS ON SAME SCALE PLATE: Deviation of pointers shows at a glance conditions of control — no need to read scale.



CONTROLLER
Plug-in Flexibility

VARIETY AND FLEXIBILITY: The most flexible and complete line of controllers offered — 34 different models, including the following variations:

1. **Remote set-point**
2. **Integral set-point (with or without air-loading)**
3. **Pipe-connected**
4. **Plug-in receiver mounted**
5. **Plug-in pipe or surface mounted**
6. **Five models of control action as follows:**
   - **a. On-Off**
   - **b. Adjustable proportional**
   - **c. Adjustable proportional plus reset**
   - **d. Fixed proportional plus reset**
   - **e. Proportional plus reset plus rate (derivative)**

Write for our product data sheets. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.
6.5.2

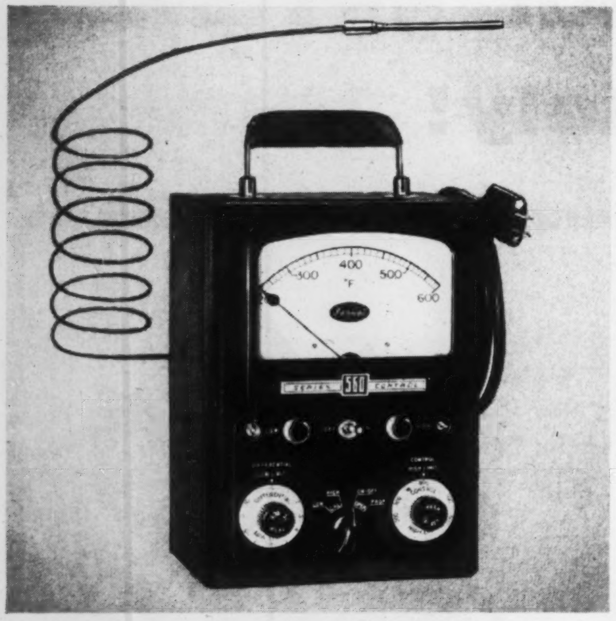
TRADE MARK
BRISTOL'S
REG U.S. PAT OFFICE

BRISTOL *POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION*

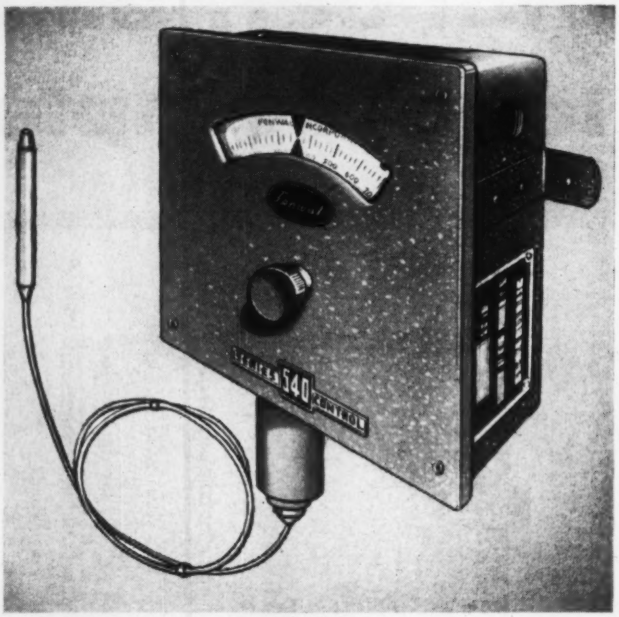
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **16** on inquiry card.

Which of these two instruments provides the temperature control accuracy you need?

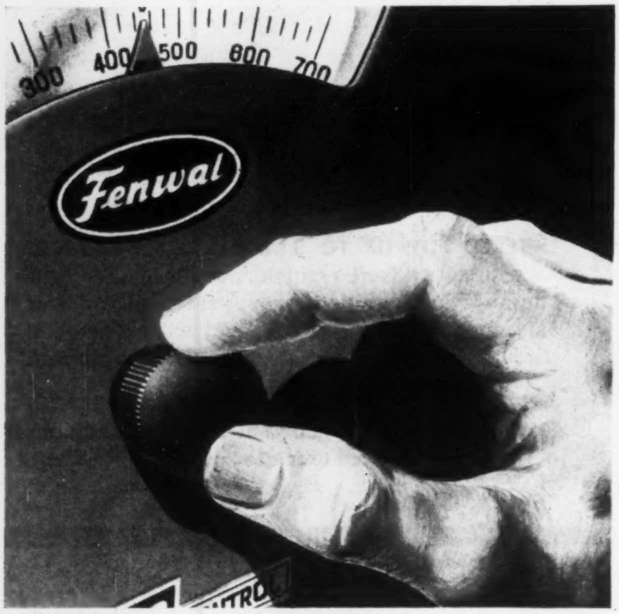


1. IT'S ELECTRONIC! The new Series 560 applies the thermistor principle in temperature indicator controls with heretofore unattainable accuracy over a scale range of 200° to 600°F. It's the *only* instrument that provides the three major control modes — (1) on-off (2) proportional (3) adjustable differential — all at the flip of a switch. Wide range of use for general laboratory, processing, molding or packaging applications.



2. IT'S MECHANICAL! The new Series 540 indicating controller combines low cost with high accuracy over a temperature range of 100° to 700°F. Temperature changes are transmitted by a bulb and bellows to an indicator control. Instrument features on-off control . . . adjustable differential . . . ambient compensation. May be flush or surface mounted. Capacity of 15 amps at 115 volts.

3. SIMPLICITY ITSELF is secret of Fenwal's Series 560 — accuracy, sensitivity and ruggedness. The thermistor's high resistance change permits operation with any length of lead wire up to 200 feet without affecting signal strength or accuracy. Thermistor is hermetically sealed in glass for stability; encased in stainless steel for ruggedness. No complex circuitry; maintenance is easy.



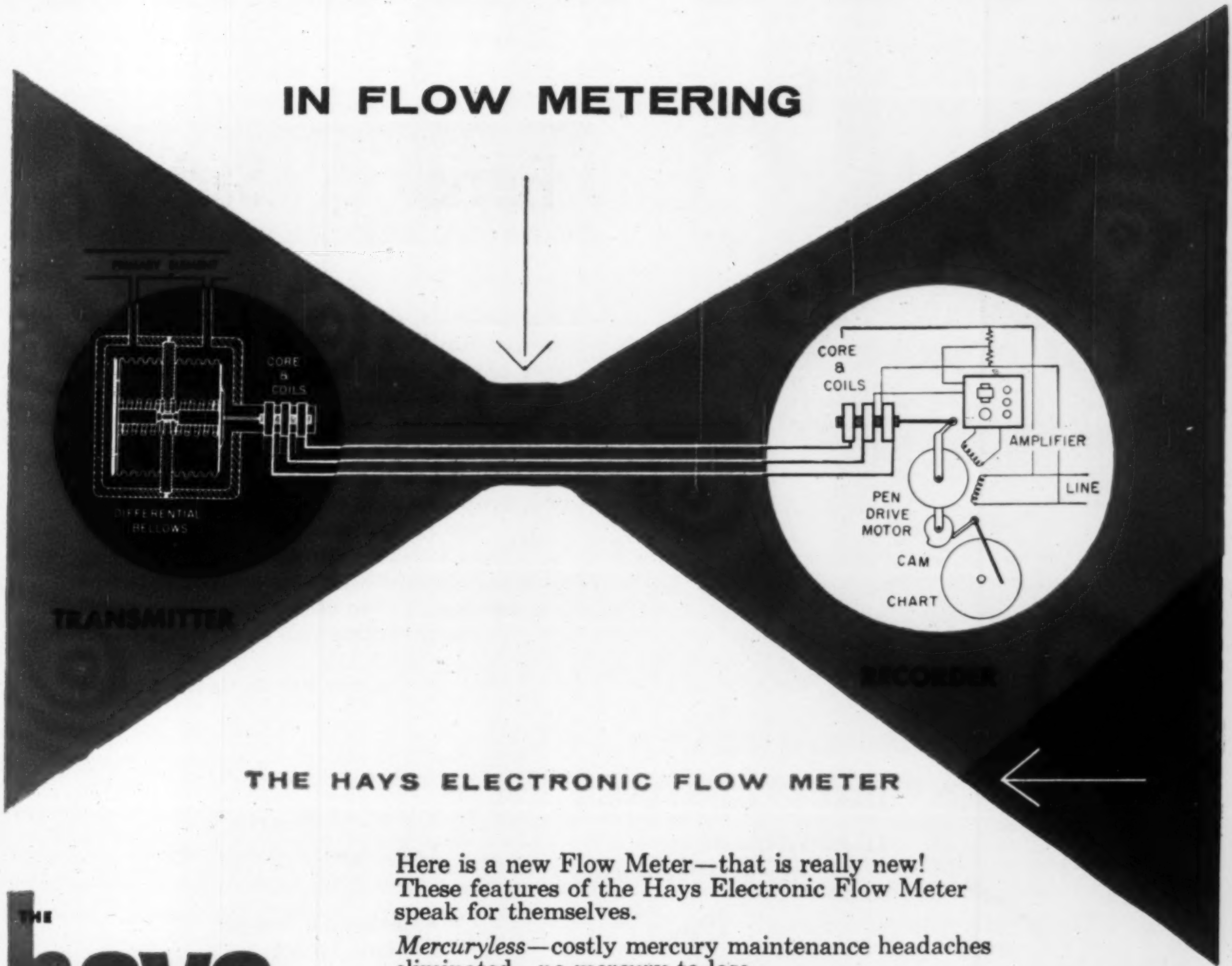
4. EASY "SET" AND "CHECK" OPERATION is a feature of Fenwal's Series 540 which is accurate to within 2% over the 100° to 700°F range, including the effects of ambient temperatures. Send for FREE NEW BULLETINS, MC122 on the Series 540, MC123 on the Series 560. Both contain full data you should have. Write to **Fenwal Incorporated, 366 Pleasant St., Ashland, Mass.**

Fenwal Controls Temperature. . . *Precisely*

For more information circle **32** on inquiry card.

new dimensions

IN FLOW METERING



THE HAYS ELECTRONIC FLOW METER

Here is a new Flow Meter—that is really new! These features of the Hays Electronic Flow Meter speak for themselves.

Mercuryless—costly mercury maintenance headaches eliminated—no mercury to lose.

Rupture-proof Bellows—provide positive protection against over-range.

Continuous integration—motor-driven continuous mechanical integrator is extremely accurate even on rapid load changes.

Electronic operation—requires only 4 seconds for full scale pen travel with accuracy of ¼% of full scale differential.

Other features include null-balance transmission, powerful motor, easy readability, accuracy unaffected by normal temperature changes. Explosion proof transmitters and wide range meters also available.

For complete information, write for Bulletin 54-1074-222.

THE hays CORPORATION

MICHIGAN CITY 8, INDIANA

Automatic Combustion Control • Veriflow Meters and Veritrol • Electronic Oxygen Recorders • CO₂ Recorders Boiler Panels • Gas Analyzers • Combustion Test Sets Draft Gages • Electronic Flowmeters • Miniature Remote Indicators • Electronic Feed Water Controls

For more information circle **18** on inquiry card.

2 Stock Answers for

Farris
NEW JERSEY
150 #
1 1/2

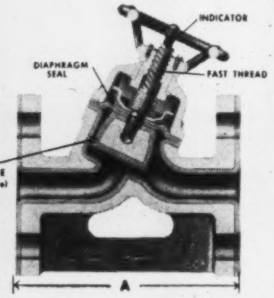
Farris X-V Series

This versatile, dependable, economically-priced hand valve is equally at home in corrosion, abrasion, vacuum or general service—wherever positive action is needed. The X-V Series disc—for positive closure—and diaphragm—for positive sealing—work independently, with only the disc exposed to pressure in the closed position, substantially increasing diaphragm life, lowering torque and providing unsurpassed vacuum service . . . No other valve does such a complete job at so little cost!

Write for Bulletin FL-154

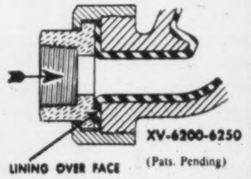
DISC for positive closure

DIAPHRAGM for positive sealing


INDICATOR
DIAPHRAGM SEAL
FAST THREAD
DISC CLOSURE (Separate)
A

NEW

Corrosion Resistant Union Ends


XV-6200-6250
LINING OVER FACE
(Pats. Pending)

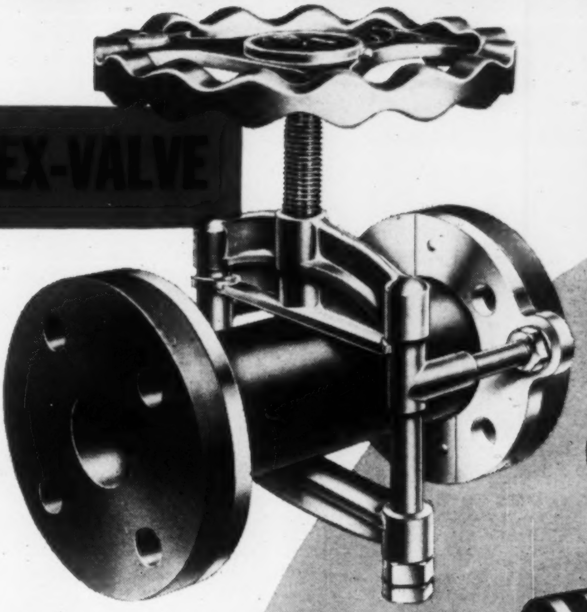
X-V Series Design Features

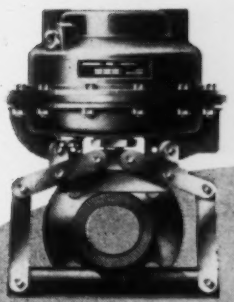
- Realistically-Priced for Low-Cost Service
- 50% Greater Capacity than Similar Type Valves
- Only Disc Area Exposed to High Vacuum in Closed Position
- No Packing Gland to Leak. Mechanism Not Exposed
- Low Hand-Wheel Torque... Easy to Operate
- Available in Lined or Unlined Models...With Corrosion Resistant Union Ends.

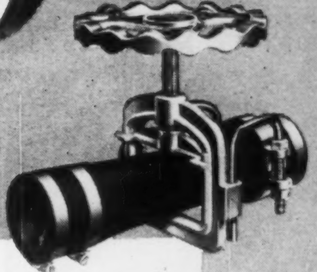
For more information circle **19** on inquiry card.

Tough Valve Problems

Farris Pinch-type FLEX-VALVE







No other valve controls the flow of hard-to-handle corrosive and abrasive materials with the efficiency and reliability of the Farris Pinch-Type FLEX-VALVE . . . because FLEX-VALVE cannot plug! This is the simplest valve made—only two components—employing the fundamental principle of pinching off the rugged, flexible valve body. Case histories show batteries of these valves in severe service for more than 20 years—and still going strong!

For complete information write for Catalog FL-382

YOUR MONEY BACK IF IT PLUGS!

Flex-Valve's Exclusive Advantages

- Will Outwear Any Metal Valve in Abrasive Service
- Full Pipe Capacity
- Maintenance Free
- Bubble Air-Tight
- Low Replacement Cost
- No Obstructions, Pockets or Internal Parts
- Available in Rubber, Neoprene, Butyl, Buna-N, Buna-S, Food Stock and Special Compounds.
- Air or Hand-operated Types

Farris

There is no compromise with experience!
There is only one FLEX-VALVE

FLEXIBLE VALVE CORPORATION
415 COMMERCIAL AVENUE, PALISADES PARK, NEW JERSEY

affiliates: FARRIS ENGINEERING CORP. • FARRIS STĀCON CORP.
FARRIS HYDROSEAL CORP. • FARRIS HYDROTORQUE CORP. • FARRIS PICKERING GOVERNOR CO.

For more information circle 19 on inquiry card.

A uniquely NEW Oscillograph
from Midwestern Instruments

Midwestern's New Model 590 incorporates every feature necessary for a successful flight-test instrument.

Specially designed for remote control*

**If desired the instrument can be supplied with no controls on it. All control then originates at a remote location.*

Here's another great development in Midwestern's series of famous flight-test instruments. It is based on extensive experience applying other Midwestern oscillographs to many combinations of environmental conditions. One of the many features is a remotely-controlled jump-speed system. Speed may be changed at any time by simply positioning a rotary switch to the required setting. 20 recording speeds are possible with this electrically-actuated system and change gears within the oscillograph. Lamp intensities are automatically adjusted to a previously-set value for recording at the new speed. The single aluminum alloy casting is ribbed for the strength and rigidity needed under high acceleration conditions.

Write for Complete Details and Specifications

products

- OSCILLOGRAPHS (LABORATORY AND FLIGHT TEST)
- MAGNETIC STRUCTURES
- GALVANOMETERS
- AMPLIFIERS
- HYDRAULIC SERVOVALVES
- TORQUE MOTORS
- SERVOAMPLIFIERS
- DATA REPEATERS
- WATERPROOF CONNECTORS
- GEOPHYSICAL EQUIPMENT

MIDWESTERN MI INSTRUMENTS

MIDWESTERN INSTRUMENTS
41st and Sheridan Road
Tulsa, Oklahoma

For more information circle **20** on inquiry card.

News...

SAMA Elects New Officers

WHITE SULPHUR SPRINGS, W. VA.—H. F. Dever was elected President of the Scientific Apparatus Makers Association at the annual meeting of the Association, April 26. Dever, President, Minneapolis-Honeywell Regulator Co., Brown Instrument Division, Philadelphia, succeeds E. J. Albert, President, Thwing-Albert Instrument Company, Philadelphia, who has held the office for the past two years.

H. F. Dever (left) receives the gavel from E. J. Albert.

T. M. Mints, President, E. H. Sargent Co., Chicago, was re-elected treasurer of SAMA.

Newly elected SAMA section chairmen include: Louis L. Vayda, President, Bacharach Industrial Instrument Co., Pittsburgh, industrial instruments; G. H. Burrell, President, Burrell Corp., Pittsburgh, laboratory apparatus; O. L. Lethander, President, Leonard Peterson & Co., Chicago, laboratory equipment; P. R. Bassett, President, The Sperry Corp., Great Neck, L. I., N. Y., nautical, aeronautical and military instruments; L. B. McKinley, V.P., Scientific Instrument Division, Bausch & Lomb Optical Co., Rochester, N. Y., optical; and B. H. Bristol, President, The Foxboro Company, Foxboro, Mass., recorder-controller section.

Newly elected SAMA directors-at-large include: G. W. Tall, Jr., V. P., Leeds & Northrup Co., Philadelphia; R. E. Welch, W. M. Welch Mfg. Co., Chicago; E. J. Albert, President, Thwing-Albert Instrument Company, Philadelphia; Russell Brittingham, V. P., Corning Glass Works, Corning, N. Y.; and E. J. Rhein, Sales Mgr., Scientific Division, Kimble Glass Company, Toledo.

President pro tempore of the association will be appointed by the incoming board of directors.

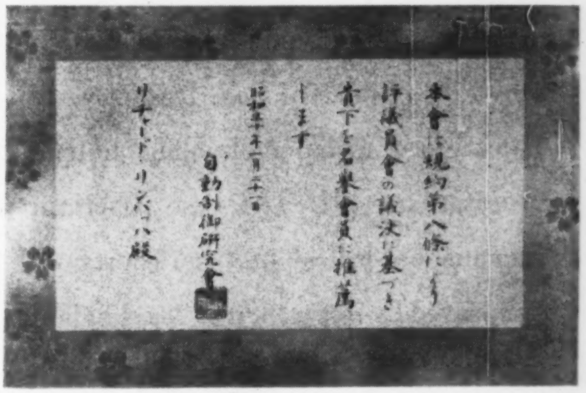
Transistor Life-test Data

NEW YORK, N. Y.—Radio Receptor Co., Inc., New York 11, N. Y., reports that in one group of 487 transistors in clamped flip-flop operation at M.I.T. for a total of 4 million transistor hours, there was one failure. In a second group of 128 transistors in unclamped flip-flop operation for a total of 1.35 million transistor hours, the number of failures was three. The transistors were unselected RR14's from standard production, manufactured in 1953.

Rimbach Honored by Japanese

CHIBA-SHI, JAPAN.—Richard Rimbach, publisher of *Instruments and Automation*, *Instrument & Apparatus News*, and *Instrument Manufacturing*, has been honored by being voted the first honorary membership in the Japanese Society of Automatic Control. His beautifully engraved scroll, shown here, reads "Richard Rimbach, Esquire—This committee, in accordance with the 8th article of (the society's) constitution, has voted and bestowed upon you honorary membership in this society. January 21, 1955. Society of Automatic Control."

R. Rimbach



本會は規約第八條により
評議員會の議決に基づき
貴下を名譽會員に推薦
します
昭和三十年一月二十一日
自動制御研究會
リチャード・リンバック殿

The first column at the left reads "Richard Rimbach, Esquire." The second column reads "Society of Automatic Control," with the society seal at the bottom. The President of the Society of Automatic Control is Dr. Kankuro Kaneshige, Institute of Industrial Science, University of Tokyo, Chiba-Shi, Japan.

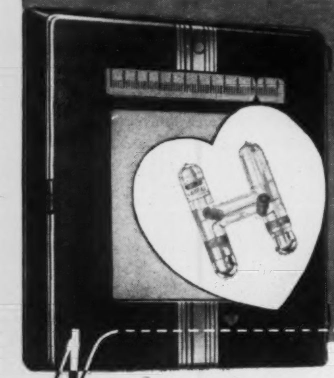
Disc-type Magnetic Recorder

HOUSTON, TEXAS.—Use of an oxide-coated 18-3/4 inch-diameter disc as the recording medium makes possible the recording up to 96 data channels on one easy-to-load plastic disc, and avoids playback discontinuities, time-consuming loading operation, data limitations, and other restrictions associated with many magnetic recording systems.

Shown in Fig. 1 is a truck-mounted seismic system using the new "magneDISC" principle of Houston Technical Laboratories, Houston 6, Texas. As recording is done in one complete revolution of the disc (5½ seconds), the

YOUR POTENTIOMETRIC INSTRUMENTS

HAVE A HEART TOO!



NO matter how perfect otherwise, the human organism isn't much good without a dependable heart. The same is true of your automatic temperature and pH control instruments.

The "heart" of most such instruments for the past quarter century has been the Eplab Standard Cell. It is a "yardstick" for translation of voltage to temperature or pH. The first American commercial cell of its type, constantly improved by research, it is "as standard as sterling".

Get ACCURATE temperature or pH control with potentiometers and make sure the standard cells are EPLAB.

The Eppley Laboratory, Inc. 2 Sheffield Ave., Newport, R. I.

EPLAB *Standard* CELLS
FOR POTENTIOMETRIC INSTRUMENTS
"As Standard as Sterling"

For more information circle **21** on inquiry card.

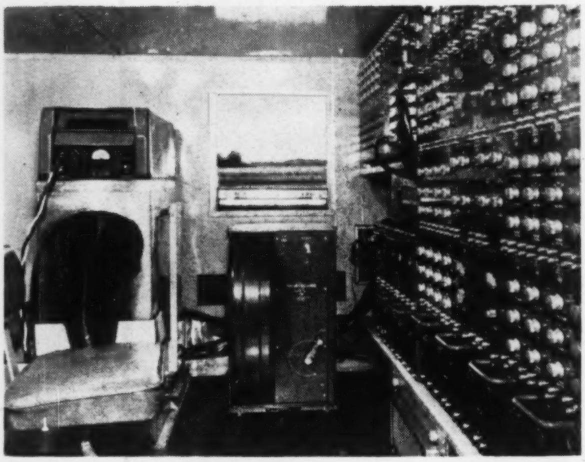


Fig. 1. Truck-mounted seismic system of Geophysical Service Inc. includes magneDISC recorder (center) and amplifier system (right).

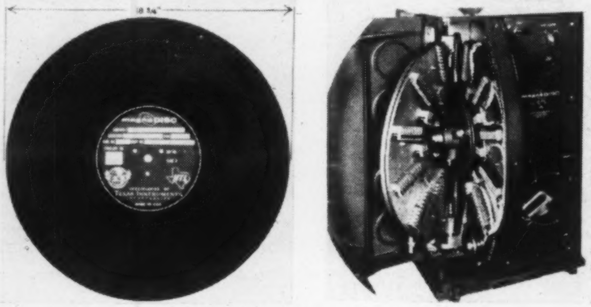


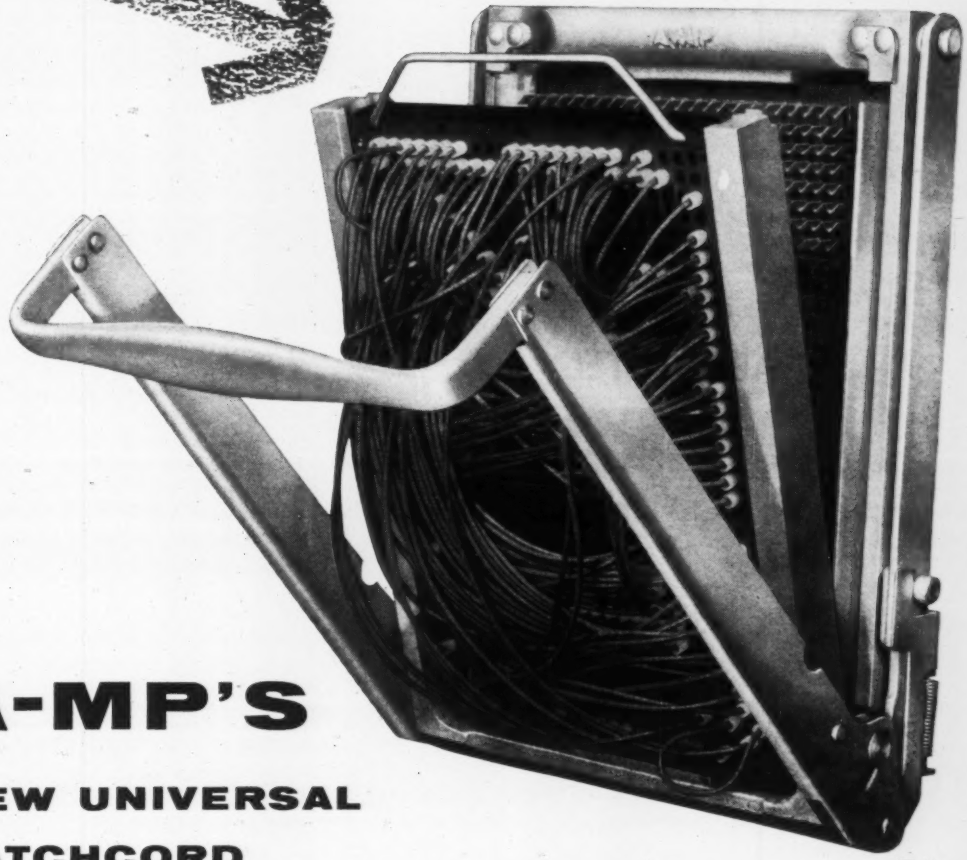
Fig. 2. Oxide-coated disc has diameter of 18 3/4 inches. Up to 96 recording heads are mounted as shown at right.

shot may be fired at any time, thus eliminating recorder starting problems. Discs are changed simply by pushing the "eject" button and slipping a new disc in place. Disc records can be stored easily.

Although use is shown in seismic recording (where advantages include immediate recording of many channels using different filter combinations, and large reduction in number of shots required) the basic feature of recording 96 channels in a 5-½ second interval opens many instrumentation possibilities (motor testing, jet engine starts, transient analysis, etc.).

The conventional magneDISC seismic system uses the standard "HTL 7000" seismic amplifier system, providing three AGC speeds and a combination of 1380 filter settings. Equipped with magnetic recording heads for 48 seismic channels and 12 auxiliary channels, the standard model can record four 24-trace shots per disc. The recorder can be supplied also with 96 recording heads, plus 19 auxiliary heads, grouped to record six 16-trace shots, two 48-trace shots, or one 96-trace shot. The disc is driven by a fork-controlled d-c motor to which it is gear coupled.

The magneDISC has signal-to-noise ratio of 46 db where peak output signal is measured at 0.75-percent distortion and noise is the measured peak value. Frequency response is ± 3 db from 10 to 300 cps. Base timing accuracy is 0.5 millisecond between traces with a timing signal accuracy of 1 part in 10,000. The measured harmonic distortion is 0.75 percent. Recording time is 5 seconds after the time break. Demodulator output is 70 millivolts rms at 2200 ohms, and 3 millivolts at 100 ohms for 0.25 volt input at 250,000 ohms.



A-MP'S

NEW UNIVERSAL PATCHCORD PROGRAMMING SYSTEMS

SYSTEMS are designed especially for programming required on

- Analog Computers
- Digital Computers
- Data Processing Equipment
- Test Equipment
- Automatic Control Equipment and similar devices

These units incorporate many new design features that assure reliable programming for the most critical applications. They are now available with 240, 816 and 1632 contacts.

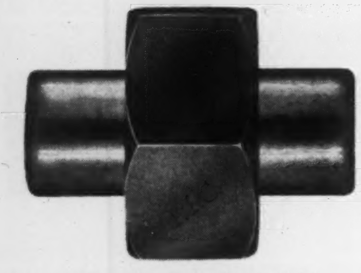
A-MP

© A-MP ®

AIRCRAFT-MARINE PRODUCTS, INC., 2100 Paxton Street, Harrisburg, Pa.
In Canada: AIRCRAFT-MARINE PRODUCTS OF CANADA, LTD., 1764 Avenue Road, Toronto 12, Ontario, Canada

For more information circle **22** on inquiry card.

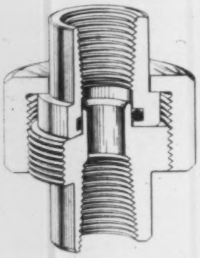
I.I.C. SUR-WAY UNIONS



ABSOLUTELY

NO LEAKS

FINGER - TIGHT



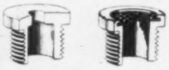
Patent pending

STANDARD UNION

The I. I. C. Sur-Way Union is designed for long, safe, trouble-free service. It's leak-proof, when only finger-tightened (vacuum or 5,000 p.s.i.)—the real answer to your instrument, laboratory, refinery or oilfield union problems.

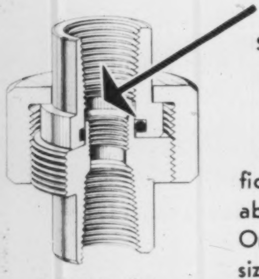
All I. I. C. Sur-Way Unions, including orifice and filter unions shown below, are available in alloy steel, and stainless steel, in all sizes 1/8" to 2" inclusive. Temperatures to 300° F.

NEW!



SCREW IN

ORIFICE AND FILTER UNIONS



Patent pending

Stainless steel screw-in orifices and filters are now available for use in Sur-Way Unions. Orifices are bored to specified sizes. Easily inserted or removed. No special tools required.

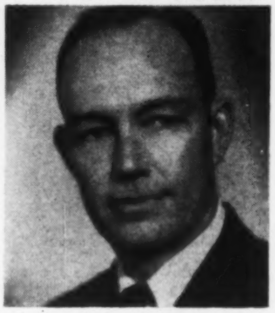
For full information—including the name of your nearest representative—write for Bulletin 58-A-2.

INDUSTRIAL INSTRUMENT CORP.

DRAWER 152 ODESSA, TEXAS

For more information circle 23 on inquiry card.

Humble Oil Committee on Instrumentation



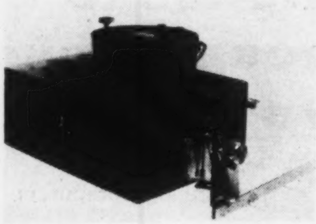
J. R. Martin

BAYTOWN, TEXAS.—Recognizing the importance of instruments to any large industry, a committee on instrumentation has been organized at Humble Oil & Refining Company's Baytown, Texas, refinery. G. S. Bays, assistant process superintendent, is chairman; other members are T. M. Hoffman, senior mechanical engineer (supervisory); J. R. Martin, general foreman, Instrument Department; B. W. Thomas, research specialist; and J. L. Walker, technical specialist.

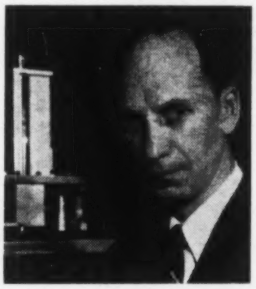
The committee will serve to bring representatives of the various refinery divisions together periodically to encourage advancements in the utilization of new instrument developments to insure that the refinery derives all practical benefits from instruments. It will search for places in the refinery where improved instrumentation might yield the most in efficiency, appraise developments in instruments, and observe instruments installed for experimental operation to assist in deciding which new instruments to place in permanent operation and which to abandon. The committee will report and make its recommendations to the general superintendent.

Ford Instrument Museum

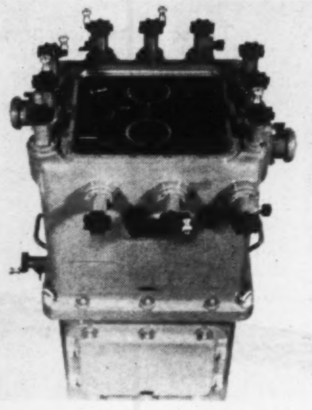
LONG ISLAND CITY, N. Y.—Ford Instrument Company, one of 14 divisions of The Sperry Corporation, observed its 40th anniversary by dedicating a permanent



First bomb sight



Raymond F. John,
President & General Mgr.



Computer
Mark 3

Range keeper
Mark I

announcing the
New REEVES REAC HIGH SPEED 400 ANALOG COMPUTER

New HIGH SPEED SERVOS

Servo multipliers have bandwidth over 50 cps. Velocity 1500 v/sec; acceleration 60,000 v/sec^2. Six gang pots; two tapped with front panel plug-in turrets for function generation.

New HIGH SPEED RESOLVERS

Vastly improved dynamic performance . . . *35-cycle bandwidth.* Rectangular and Polar operation; Full AGC either mode. Front panel plug-in turrets for easy padding for function generation.

New PROBLEM CHECK

New Reeves development permits verification of problem solution directly from equations before problem is run.

Checks
- Operation of all components used
- Patching of problem from diagram
- Diagramming of problem from equations

New CONVENIENT PATCHBAY

Available in units of 1632, 3264 or 4891 holes for maximum flexibility. Color-coded mask aids in patching. Patchboard changes possible during operation.

New POWERFUL AMPLIFIERS

New dual amplifier chassis, individually chopper-stabilized. Noise less than 3 mv rms *in cabinet.* Phase shift 0.025° @ 100 cps. Bandwidth 10KC under cabinet conditions.

New
BUILDING-BLOCK CONSTRUCTION

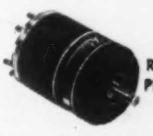
. . . an exclusive Reeves design principle that permits assembly of computer elements in any desired combination to form exactly the computer necessary to do a particular job or to expand an existing installation. REAC 400 can be assembled, component by component, to fit specific requirements at minimum cost, time, space and effort. REAC 400 is completely adaptable to the scope and complexity of your control problem, now or in the future.

Reeves
INSTRUMENT CORPORATION

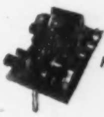
REEVES INSTRUMENT CORPORATION
A Subsidiary of Dynamics Corporation of America
225 East 91st St., New York 28, N. Y.

REAC Analog Computers

Precision Floated GYROS



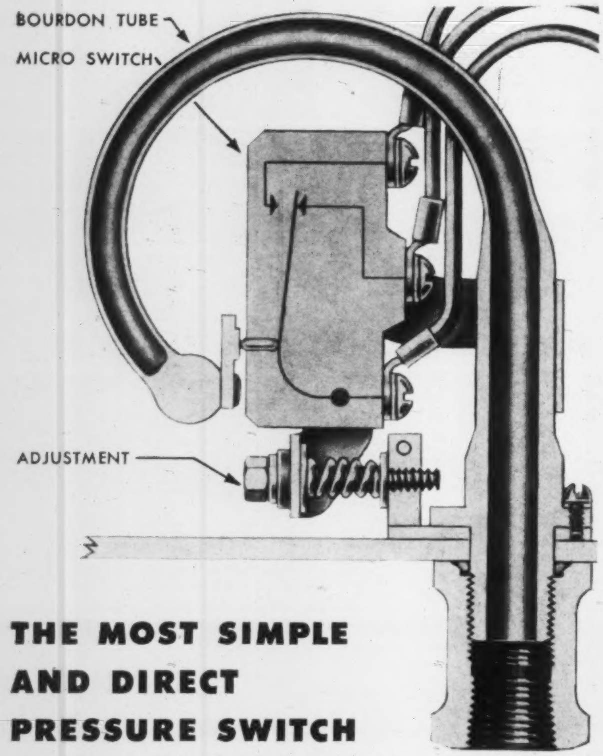
Precision RESOLVERS and PHASE SHIFTERS



SERVO MECHANICAL PARTS

IRV55

For more information circle **24** on inquiry card.



THE MOST SIMPLE AND DIRECT PRESSURE SWITCH

for 500 to 12,000 P. S. I. Proof Pressures

EXTREMELY ACCURATE

Simplicity of direct acting design plus rugged precision construction make for long, unchanging repeat accuracy.

Note, that we don't use

LINKAGES AND BEARINGS

which, as they wear, cause settings to drift.

IN ANY POSITION

on moving equipment, even under vibration, switch performs with equal efficiency.

Because we don't use

LIQUID SWITCH ELEMENTS

which require that the pressure switch be mounted absolutely vertical, which make it very critical to vibration.

BARKSDALE VALVES

PRESSURE SWITCH DIVISION

5125 Alcoa Avenue, Los Angeles 58, California

Send operating data and specifications bulletins 302

NAME ________ TITLE ________

COMPANY ________

ADDRESS ________

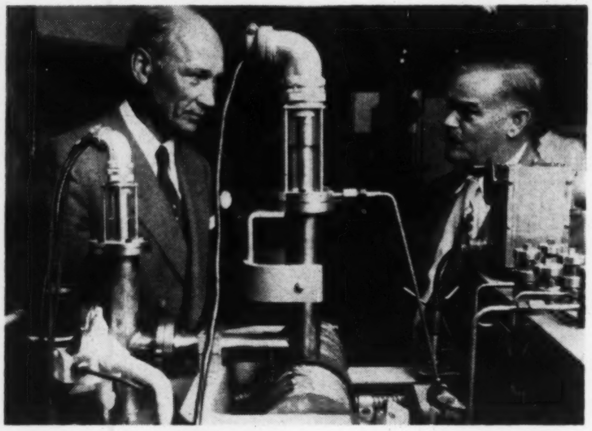
CITY ________ ZONE ______ STATE ________

For more information circle **25** on inquiry card.

company museum illustrating progress in the science of weapons control since 1915. Chief exhibits in the museum, only one in the Greater New York area devoted primarily to the history of weapons control, include the world's first automatic tracking bombsight, first time-of-flight clock, first anti-aircraft computer and gun director, first automatic computer and plotter for artillery battery direction, and first automatic "brain" for controlling gunfire, the Range Keeper, Mark I (see illustration).

In dedicating the museum, Mr. Raymond Jahn, President and General Manager of the Ford Instrument Company said: "This room is a memorial to Hannibal C. Ford, our founder. Mr. Ford revolutionized naval warfare by developing and building the first computer to automatically solve the problem of range between two moving ships. From his historic Range Keeper Mark I, grew all the complex fire control mechanisms of our present-day naval vessels."

AEC Receives 100 Spectrometers



FULLERTON, CALIF.—Last of 100 mass spectrometers built by Beckman Instruments, Inc. for the Atomic Energy Commission is turned over to AEC nearly a year ahead of schedule. Dr. Arnold O. Beckman (left), officially delivers the instrument to Raymond D. High, Carbon and Carbide Chemicals Co., AEC plant operators. Mass spectrometers will be used in quality control during uranium processing, and will aid current program to boost atomic energy stockpiles and to expand atomic-energy production facilities.

First Transistorized CRO

CLIFTON, N. J.—For the first time, the cathode-ray oscillograph has been experimentally developed into a battery-operated unit which employs practical transistors instead of conventional vacuum tubes. This development was performed by the Instrument Division of Allen B. Du Mont Laboratories, Inc. The complete oscillograph has a volume of 1/4 cubic foot and weighs 16 pounds. The power required by the circuits is less than one watt and the entire unit consumes less than 5 watts. The response of the transistor oscillograph is 20 cycles to 150 kc, down three db. The sensitivity is 200 mv per inch thru the high-impedance input and 500 mv per inch thru the low impedance input. The unit has a rise time better than 2 microseconds and a writing rate of from 3 to 100,000 microseconds per inch.

If you package
liquids or
free-flowing solids,
even in opaque containers,

HYTAFILL

x-ray monitor

belongs in your production picture

Photo courtesy Carling Brewing Co.

You make sure of full measure ... save on expensive overfilling

MANY leading brewers, beverage producers and food processors are now using General Electric HYTAFILL in their production. They have found that this modern x-ray method for checking container fill makes a big contribution to plant efficiency as well as quality control.

HYTAFILL inspects every container that passes along the line for both over and under fill simultaneously . . . and is capable of checking up to 900 containers per minute.

There's no costly installation problem. HYTAFILL is compact . . . readily adaptable to existing conveyor lines. Both tube head and detector are sealed . . . can be washed with steam or hot water. Control panel may be positioned anywhere within 50 feet of the conveyor line.

Liquid level checking is just one of many ways x-ray applied by General Electric serves industry. For an expert appraisal of your particular needs, call your G-E x-ray representative or write direct. X-Ray Department, General Electric Company, Milwaukee 1, Wisconsin. For facts on HYTAFILL, ask for Pub. BL-64.

Progress Is Our Most Important Product

GENERAL ELECTRIC

For more information circle **26** on inquiry card.

Events . . .

For Computer Events see page 955.

INSTRUMENTS and AUTOMATION

June 27-July 1

Case Institute course on Resistance Strain Gage Techniques. For information write Case Institute of Technology, 10900 Euclid Ave., Cleveland 6, Ohio.

June 27-29

First Annual Meeting of the American Nuclear Society, at Pennsylvania State University, "will be representative of all major interests in peacetime atomic energy." Write to Prof. W. W. Miller, Pennsylvania State University, State College, Pa.

June 28-July 9

Third British Instrument Industries' Exposition at Earl's Court, London. For information write F. W. Bridges & Sons, Ltd., Grand Bldg., Trafalgar Square, London W. C. 2, England.

July 10-23

Technical Association of the Pulp and Paper Industry Conference on Statistics in the Paper Industry, Forest Products Laboratory, Madison, Wis. For information write Fred R. Sheldon, Becco Chemical Div., Food Machinery Corp., Buffalo 7, N.Y.

July 20-22

The Instituto Tecnologico y de Estudios Superiores de Monterrey, announces the first Annual Short Course on Instrumentation for Industry, Monterrey, N.L. Mexico. For information write Ing. Carlos Lopez Garcia, Departamento de Ingenieria Quimica.

July 25-27

Conference on Systems Engineering, Purdue University, Lafayette, Indiana. For information write John M. Cage, c/o Purdue University.

August 1-12

University of Michigan Summer Session on "Digital Computers and Data Processors—A Report from the Users." For information write John W. Carr, Digital Computation Dept., Willow Run Research Center, University of Michigan, Ypsilanti, Mich.

August 17-19

"The Computing Laboratory in the University", University of Wisconsin, Madison, Wis. For information write Preston C. Hammer, Numerical Analysis Laboratory, University of Wisconsin.

August 22-23

"Electronics and Automatic Production" Symposium, sponsored by Stanford Research Institute and National Industrial Conference Board, at San Francisco. For information, write to the Institute at Palo Alto, Calif.; or to the NICB, 247 Park Ave., New York, N.Y.

August 22-Sept. 2

Summer Program in "Numerical Control of Machine Tools" will be held at Massachusetts Institute of Technology. For information write Summer Session Office, Rm. 7-103, M.I.T., Cambridge 39, Mass.

August 24-Sept. 3

12th Annual British National Radio Show will be held at Earls Court, London, England. For information write Andrew Reid, 11, Garrick St., London WC. 2, England.

August 24-26

1955 IRE Western Electronics Show and Convention, Civic Auditorium, San Francisco, Calif. For information write W. A. Edson, Applied Electronics Laboratory, Stanford, Calif.

September 12-16

Tenth Annual Conference and Exhibit of the Instrument Society of America will be held at Shrine Exposition Hall and Auditorium, Los Angeles, Calif. For information write Fred J. Tabery, 3443 South Hill St., Los Angeles 7, Calif.

September 14-16

Annual General Meeting of the Association for Computing Machinery, Moore School of Electrical Engineering, University of Pennsylvania, Phila. For information write Sidney Kaplan, R.C.A., Building 13-2, Camden 2, N. J.

September 28-30

Sixth TAPPI Testing Conference, Sheraton-Kimball Hotel, Springfield, Mass. For information write Wm. Schoenberg, 1878 East 18th St., Cleveland 14, Ohio.

October 3-5

11th Annual National Electronics Conference, Hotel Sherman, Chicago, Ill. For information write J. Kocek, c/o Illinois Bell Telephone Co., 208 W. Washington St., Rm 300, Chicago 6, Ill.

October 3-6

25th Annual Meeting of Society of Exploration Geophysicists, Shirley Savoy Hotel, Denver, Colo. For information write Colin Cambell, 624 S. Cheyenne, Tulsa, Oklahoma.

October 5-14

Tenth General Conference on Weights and Measures will be held in Paris and Sevres, France. For information write National Bureau of Standards, U. S. Dept. of Commerce, Washington 25, D.C.

October 13-15

Committee on Vacuum Techniques, Inc., will hold their Second Symposium on Vacuum Technology at Mellon Institute, Pittsburgh 13, Penna. For information write Rudy Koehler, c/o Box 1282, Boston 9, Mass.

October 24-25

First Annual Technical Meeting of the Professional Group on Electron Devices of the I.R.E., will be held at The Shoreham Hotel, Washington, D.C.

October 27-28

11th Annual Meeting of National Conference on Industrial Hydraulics, La-Salle Hotel, Chicago, Ill.

November 3-4

Fourth Annual Louisiana Polytechnic Institute Instruments Conference, Ruston, Louisiana. For information write School of Engineering.

November 13-18

American Society of Mechanical Engineers' 75th Annual Meeting, Hotel Congress, Chicago, Ill.

November 14-17

Second International Automation Exposition will be held at Chicago's Navy Pier. For information write The Second International Automation Exposition, 845 Ridge Ave., Pittsburgh 12, Penna.

plan NOW for the **Second**

INTERNATIONAL AUTOMATION EXPOSITION

Chicago's Navy Pier

fill out the following: **November 14-17**

2nd Automation Show
845 Ridge Ave.
Pittsburgh 12, Pa.

Name ....
Company ....
Title ....
Address ....
....

✓ check for . . .
☐ Advance Registration
☐ Exhibit Information
☐ Computer Clinic Registration

Note:

ASME Diamond Jubilee Annual Meeting will be held November 13 thru 18, at the Hotel Congress, Chicago—just a short ride to or from the AUTOMATION show.

Major advance in Low Pressure SOLENOID VALVES

Extra heavy industrial type construction with tight seating assured

—for manufactured
and natural gas,
air, propane, butane,
water, gasoline
and light fuel oil
—to 180°F.

Mount this new ASCO Low Pressure Solenoid Valve in *any* position without affecting its operation. For pressures up to 7 Psi, the Bulletin 8030A helps give full design flexibility to gas pilot applications on industrial ovens and furnaces — automatic dispensing and vacuum holding applications.

And ASCO combines ruggedness with simplicity by housing a single moving element — the stainless steel core and composition disc — in an extra heavy forged brass body.

Operation is just as remarkable. Energizing the solenoid with only 10 watts provides positive opening action. Both 3/8″ and 1/2″ pipe sizes feature oversized ports (3/8″ orifice) for greater flow at an exceptionally low pressure drop.

There's *one* source that solves virtually any solenoid valve problem—ASCO. For full data on this new Low Pressure Solenoid Valve, write today for Application and Development Report 8030A.

ASCO

Automatic Transfer Switches
Electromagnetic Controls
Solenoid Valves

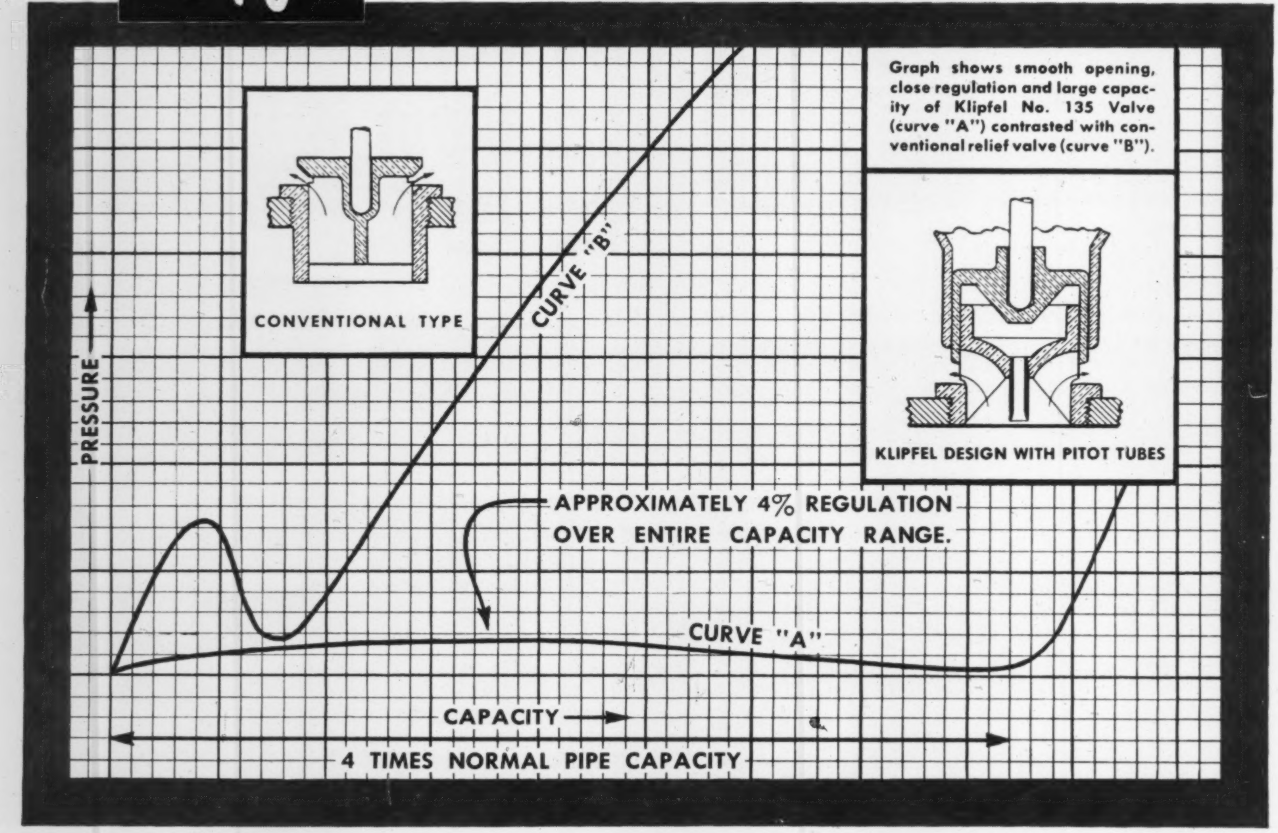
Automatic Switch Co.
385-T Lakeside Avenue • Orange, N. J.

For more information circle **27** on inquiry card.

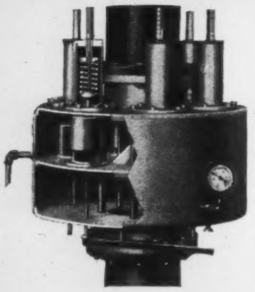
Using relief valves?

CHECK THE PERFORMANCE

OF Klipfel NO. 135 SINGLE and MULTIPORT VALVES



Graph shows smooth opening, close regulation and large capacity of Klipfel No. 135 Valve (curve "A") contrasted with conventional relief valve (curve "B").



Single or multiport, the Klipfel No. 135 maintains steam back pressure accurately. Among the features which have made it a favorite with operating and maintenance men are:

INNER VALVE—*an inverted cup slides smoothly on a piston which is integral with the threaded seat bushing.*

EXTERNAL SLEEVE—*an extra feature—permits close regulation with variable outlet pressure by venting spring chamber to a constant pressure source.*

SPRING—*extra long with low spring scale.*

BODY—*in single port, bronze, semi-steel or steel casting. In multiport, all-welded steel plate body.*

PRESSURE RANGE—*single port, up to 300 P.S.I.G.; multiport, vacuum to 20 P.S.I.G.*

PERFORMANCE CHARACTERISTICS

Compensated Spring Loading—
by using fluid velocity.

Tight Closing—
with thin edged seat for low venturi effect.

Chatter-proof Operation—
though inherent dash-pot construction.

Multiport Valves—
open in sequence minimizing wire drawing and improving regulation. Positive testing of each valve with external handle.

FOR FULL DATA on the Klipfel No. 135, write Dept. C-6.

Klipfel VALVES INC.

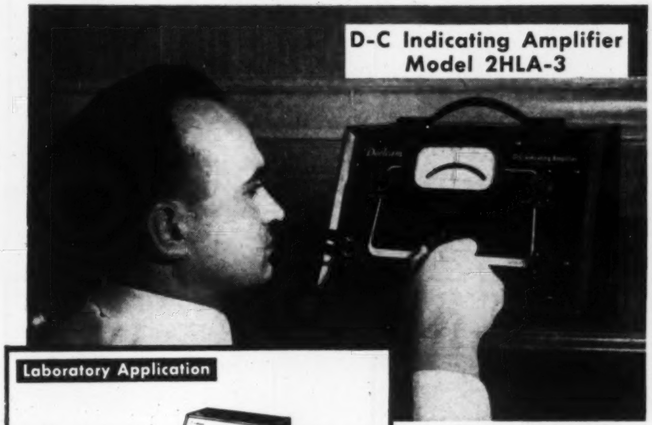
DIV. OF HAMILTON-THOMAS CORP.
HAMILTON, OHIO
EXPORT DEPT., 1010 SCHAFF BLDG.
PHILADELPHIA, PA.

For more information circle **28** on inquiry card.

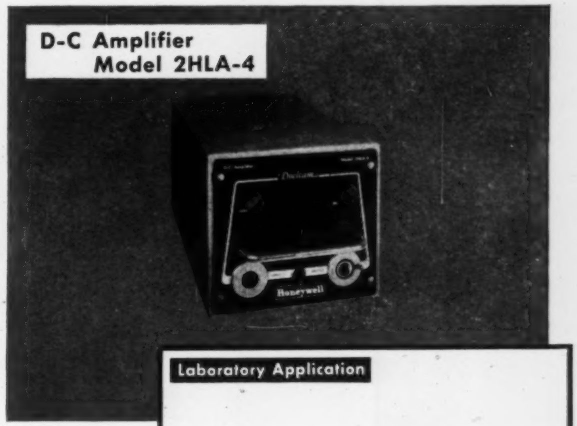
NEW DOELCAM PROPORTIONAL AMPLIFIERS OFFER GREATEST VERSATILITY IN LOW LEVEL D-C SIGNAL APPLICATIONS

HERE ARE TWO PRECISION AMPLIFIERS incorporating the new Doelcam Second Harmonic Magnetic Converter as the input stage. This unique design concept makes possible low noise level, high sensitivity and linear output.

The Model 2HLA-3 is both a Linear Indicator and a Multirange Amplifier. The Model 2HLA-4 is a Single Range Amplifier with provision for interchanging range by plug-in units. Both are ideal for either laboratory or production use.

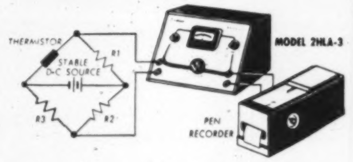


D-C Indicating Amplifier
Model 2HLA-3



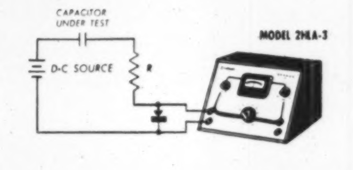
D-C Amplifier
Model 2HLA-4

Laboratory Application


THERMISTOR
R1
STABLE D-C SOURCE
R3
R2
MODEL 2HLA-3
PEN RECORDER

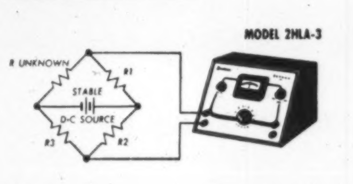
The fast thermal response of highly sensitive thermistors can be accurately measured and recorded.

Production Application


CAPACITOR UNDER TEST
D-C SOURCE
R
MODEL 2HLA-3

Measuring the dielectric leakage current of capacitors.

Production Application


MODEL 2HLA-3
R UNKNOWN
R1
STABLE
D-C SOURCE
R3
R2

Production testing of precision resistors or potentiometers in a balanced bridge circuit.

Write for Bulletin IA-4   Write for Bulletin SRA-4

WHETHER YOUR APPLICATION is in the laboratory or on the production line, one of these two instruments is ideally suited. Their versatility is illustrated in the diagrams shown here. The Model 2HLA-3 is both a precision measuring laboratory instrument and a rugged production test instrument. The Model 2HLA-4 is designed for rack mounting as a component part of a control or measuring system.

HERE ARE SOME PERFORMANCE CHARACTERISTICS:

High Gain — 10^4 for 2HLA-3
10^5 for 2HLA-4

Low Noise — less than 5 microvolts equivalent input

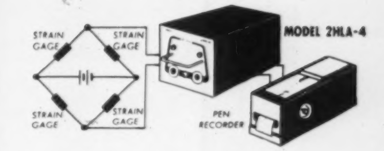
Linear Amplification—better than ± 1% on all ranges

High Stability — zero drift less than 10 microvolts

Rugged — withstands inputs of 1.5 volts

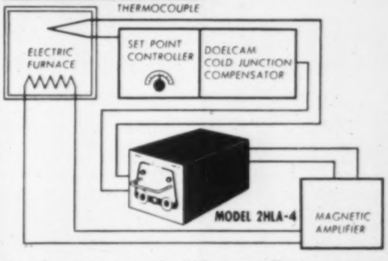
SPECIAL APPLICATIONS: These instruments can be easily adapted to provide linearity down to 0.1%, isolated input, multiple inputs, increased gain, increased power output and extended frequency response. Send us your complete requirements.

Laboratory Application


STRAIN GAGE
STRAIN GAGE
STRAIN GAGE
STRAIN GAGE
MODEL 2HLA-4
PEN RECORDER

Dynamic stress measurements made with linear response up to 20 cps.

Control Application


THERMOCOUPLE
ELECTRIC FURNACE
SET POINT CONTROLLER
DOELCAM COLD JUNCTION COMPENSATOR
MODEL 2HLA-4
MAGNETIC AMPLIFIER

Temperature control within a small temperature range.

Doelcam

A DIVISION OF MINNEAPOLIS-HONEYWELL

H
HONEYWELL

SOLDIERS FIELD ROAD
BOSTON 35, MASS.

Instruments for Measurement and Control

Synchros • Gyros • Amplifiers • Microsyns • Servo Motors

For more information circle **29** on inquiry card.

There is No Distortion of the Tubes.....

even when tied in a knot

CRESCENT

POLYETHYLENE

MULTITUBE

with Spirally Cabled Tubes

For Instrument
and Control Tubing

CRESCENT POLYETHYLENE MULTITUBE is composed of 2 to 19, ¼″ O.D. Polyethylene tubes up to 1000 feet in length, spirally cabled together to allow bending with a short radius without distortion of the tubes. The tubing assemblies are protected by a flexible interlocked galvanized steel armor (Type PA), or by a tough corrosion-resistant thermo-plastic sheath (Type PT). Tubes are furnished in seven contrasting colors for ready identification of each tube at both ends. Both constructions are flame retarding.

Economy is achieved in the initial cost of CRESCENT POLYETHYLENE MULTITUBE and its accessories, as well as in substantial savings in labor costs of installation. Moderate to long length runs of light weight and compact MULTITUBE assemblies result in fewer connections and fittings, lower cost for supports or racks, ease of mounting, less space being used.

CRESCENT POLYETHYLENE MULTITUBE can be pulled through conduit or raceways.

Send For New Bulletin
Giving Complete Information
And Engineering Data

Shown here—
19 TUBES
TYPE PT

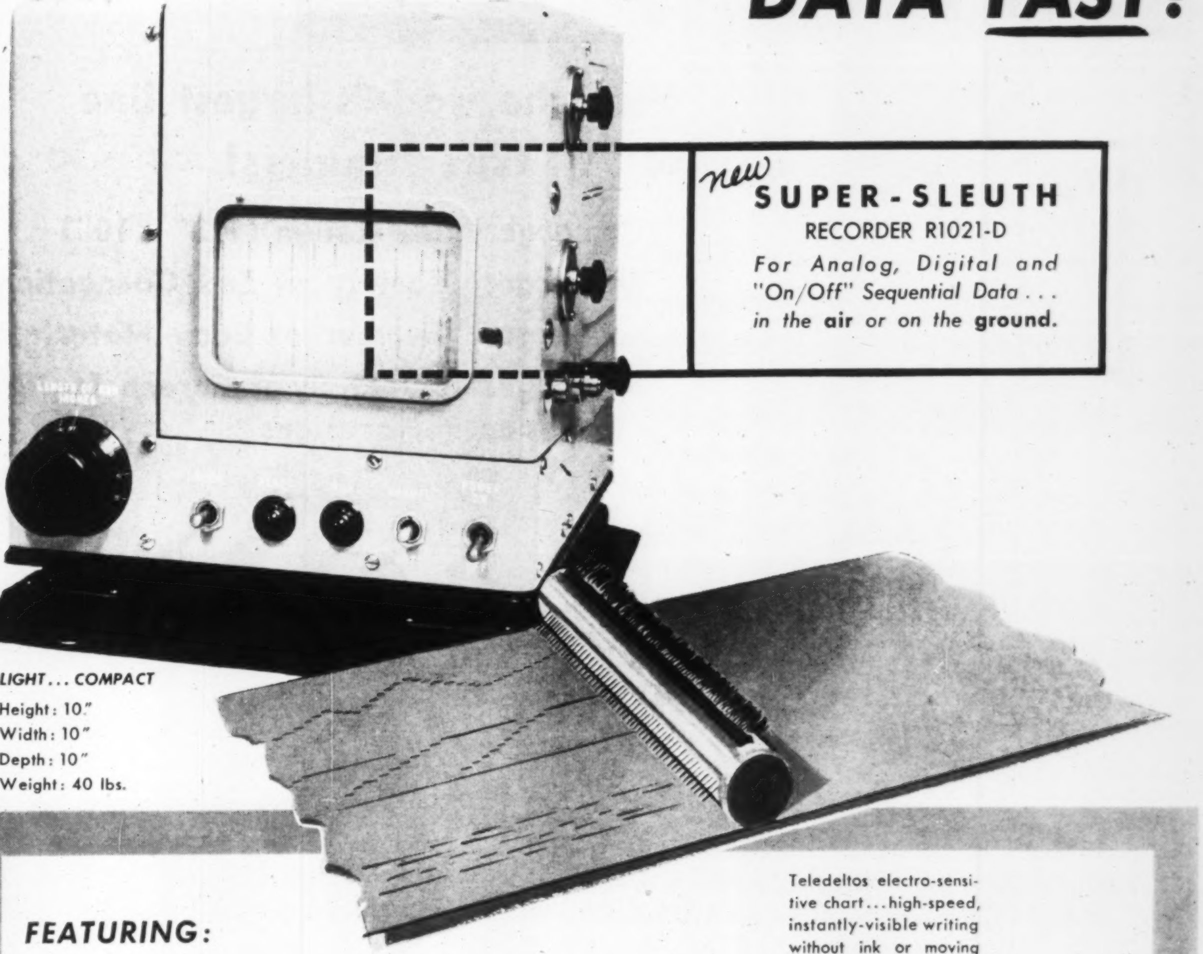
CRESCENT

INSULATED WIRE & CABLE CO.

OLDEN & TAYLOR STS., TRENTON, NEW JERSEY

For more information circle 30 on inquiry card.

A SHORTCUT FOR GETTING *Accurate* DATA FAST!



new
SUPER-SLEUTH
RECORDER R1021-D
For Analog, Digital and "On/Off" Sequential Data . . . in the ***air*** *or on the* ***ground.***

LIGHT . . . COMPACT
Height: 10"
Width: 10"
Depth: 10"
Weight: 40 lbs.

Teledeltos electro-sensitive chart . . . high-speed, instantly-visible writing without ink or moving writing elements.

FEATURING:

- Ease of visual readability.
- 212 writing styli unaffected by vibration and shock.
- Simplified semi-automatic and automatic data reduction techniques.
- High capacity simultaneous sequential data recordings.
- Low cost per channel of recorded data.

The **Super-Sleuth** Recorder R1021-D has many commercial and industrial applications in automatically testing, monitoring, measuring and recording data for management evaluation.

Radiation, Inc. fixed multi-styli recording systems, featuring large data handling capabilities, help to economically simplify the solutions to instrumentation problems in Aircraft, Missile, Chemical, Mining, Petroleum and other industries. We invite you to submit your inquiries and application problems.

WRITE FOR FULL DETAILS — **RADIATION, Inc.**
Dep't. 101 • P.O. Box #37 • Melbourne, Florida

For more information circle **31** on inquiry card.

YOUR CHOICE

600
600
600
LESLIE
1500
1500
LESLIE
125
LESLIE

from the world's largest line of "Y" type strainers!

- **Largest Size Range (1/8" - 10")**
- **Largest Variety of End Connections**
- **Largest Number of Body Materials**
- **Largest Selection of Screen Materials and Perforations**

—A selection of over 150 *Standard* LESLIE Self-Cleaning Strainer Body and Screen Combinations. Sizes 1/8" to 10"

—Cast iron, Bronze, Forged Steel, Carbon Steel, Carbon-moly, Chrome-moly and Stainless Steel bodies are available from stock.

—Designed for all pressure standards up to 2500 psi and 1050° F.T.T. and 6000 psi at 100° F. Screwed, socket or butt welding ends, plain, raised face or ring-type flanges for all existing standards. Sizes 1/8" to 10".

—Protect an entire piping system with a LESLIE strainer for every phase of the process. Send for bulletin 5308 for the complete story.

TRADE
LESLIE
MARK

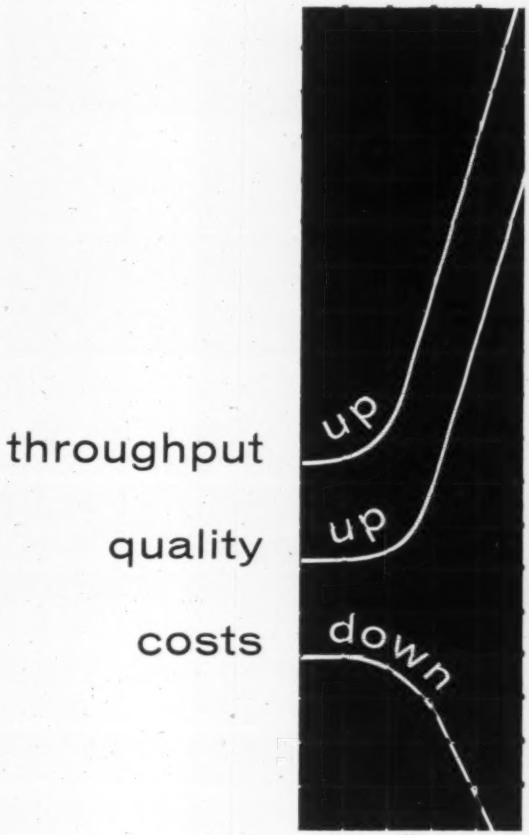
SELF-CLEANING STRAINERS

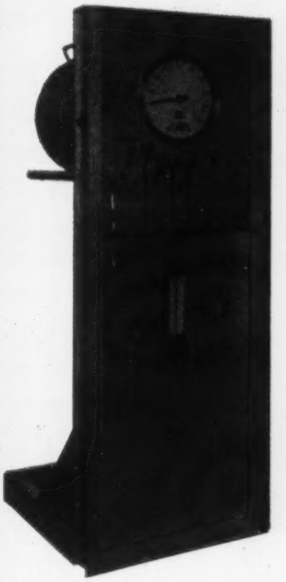
LESLIE CO., 299 GRANT AVENUE, LYNDHURST, NEW JERSEY

3313

"REGULATORS SINCE 1900 — STILL FAR AHEAD IN QUALITY AND PERFORMANCE"

For more information circle **7** on inquiry card.

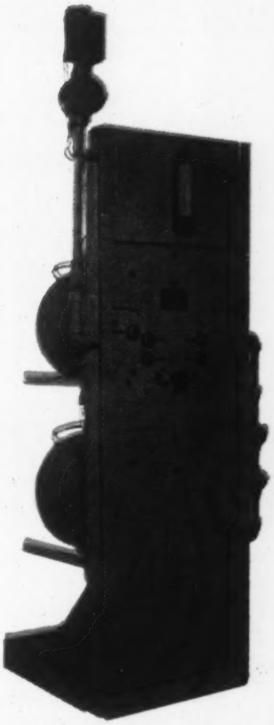




process refractometer

(Type 38-201)

For monitoring or control of fractionating towers and stream-blending operations. Automatic control can be established through completion of composition-actuated feedback loop . . or information can be telemetered to pen recorders in the refinery control room. SEND FOR BULLETIN CEC 1839-X5



infrared analyzer

(Type 38-101)

Handles up to five streams at a rate of 5 analyses per hour per stream, i.e., 12-minute cycle period. Increases fractionator capacity by holding product composition steady and minimizing operational fluctuations. Eliminates the time lag between sampling and laboratory batch analysis. SEND FOR BULLETIN CEC 1840-X5

Here are the first "Consolidated-Phillips" *continuous* process analyzers . . . units which provide analytical data while it's valid, *before* variables have changed. With these two instruments on stream, product quality and production go up . . . costs go down. You can install and maintain them for less, on an hourly basis, than a laboratory technician's salary. They need no elaborate facilities, can operate out-of-doors, are completely explosion-proof.

Consolidated-Phillips process analyzers have been proving their ability . . . and dependability . . . under actual plant conditions for several years. Originally designed and formerly manufactured by Phillips Petroleum Company, they are now backed by Consolidated Engineering's nationwide service organization . . . assurance of interruption-free operation for years to come.

Whether your process instrumentation needs are for a single unit or a complete analysis-and-control system, you'll find it will pay to talk to a CEC Field Engineer. Write us today.

Consolidated Engineering

Corporation

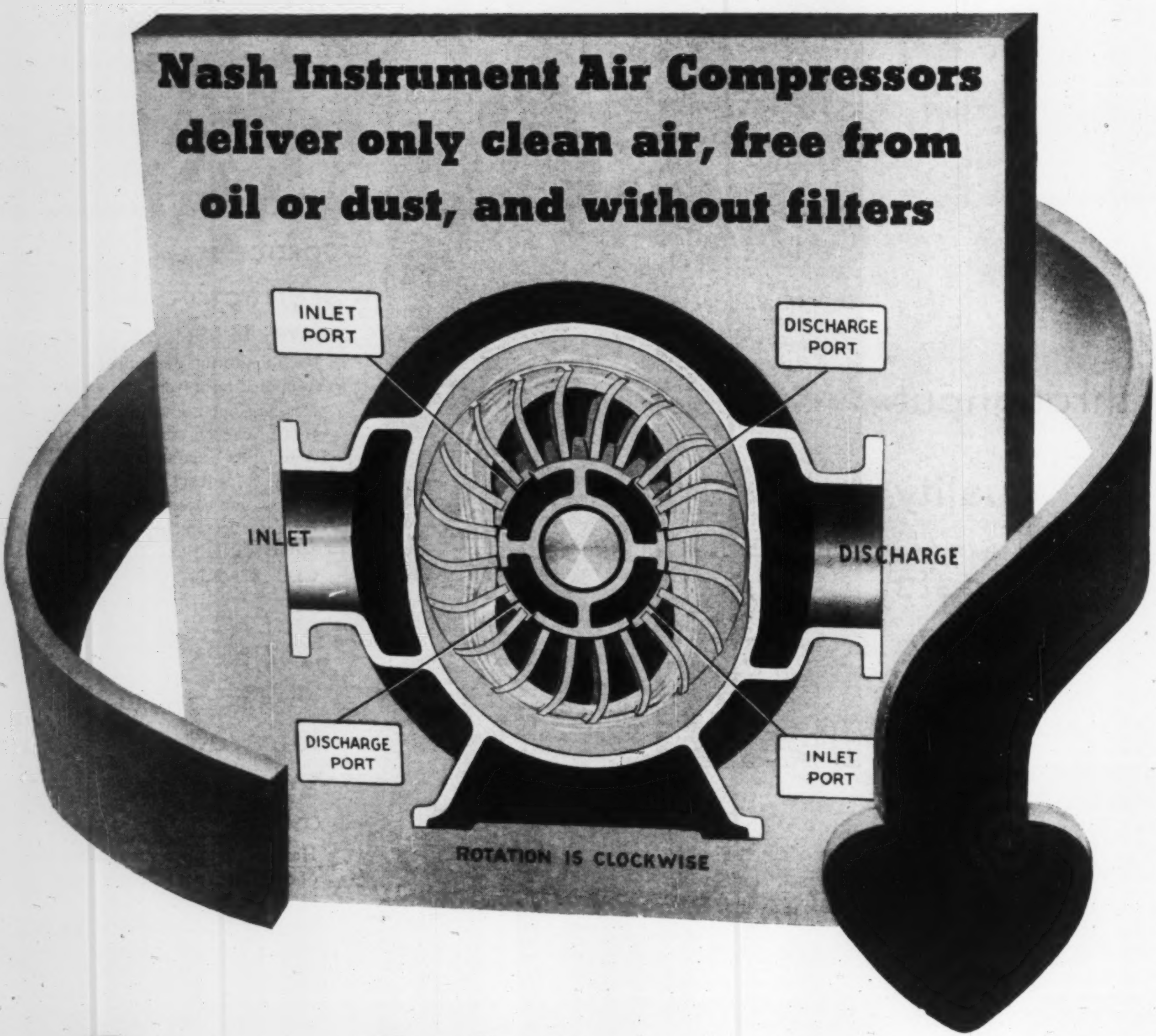
ELECTRONIC INSTRUMENTS
FOR MEASUREMENT AND CONTROL

300 North Sierra Madre Villa,
Pasadena 15, California

Sales and Service Offices Located in: ***Albuquerque, Atlanta, Boston, Buffalo, Chicago,, Dallas, Detroit, New York, Pasadena, Philadelphia, San Francisco, Seattle, Washington, D.C.***

For more information circle **148** on inquiry card.

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters



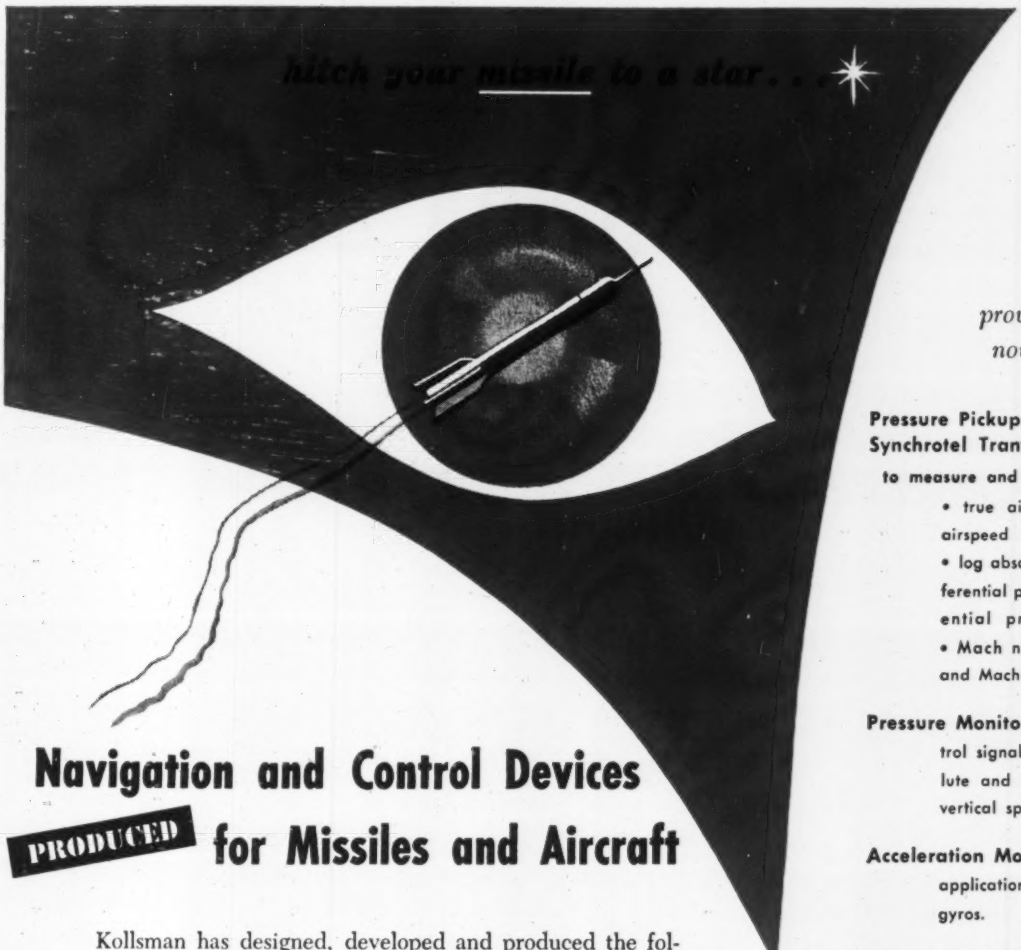
Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.


hitch your missile to a star . . .

Navigation and Control Devices PRODUCED for Missiles and Aircraft

Kollsman has designed, developed and produced the following navigation and control systems and components:

FOR NAVIGATION OR GUIDANCE

Photoelectric Sextants for remote semi-automatic celestial navigation. Flight tests in jet aircraft gave an overall geographical positional accuracy of two miles.

CLASSIFIED **Automatic Astrocompasses** for precise automatic celestial directional reference and navigation.

Photoelectric Tracking Systems For many years Kollsman has specialized in high precision tracking systems.

Periscopic Sextants for manual celestial observations.

CLASSIFIED **Computing Systems** to provide precise data for automatic navigation and guidance, operated by optical, electromechanical, and pressure sensing components.

Photoelectric Sextant

FOR CONTROL

proven components now in production

Pressure Pickups and Synchrotel Transmitters

to measure and electrically transmit • true airspeed • indicated airspeed • absolute pressure • log absolute pressure • differential pressure • log differential pressure • altitude • Mach number • airspeed and Mach number.

Pressure Monitors — to provide control signals for altitude, absolute and differential pressure, vertical speed, etc.

Acceleration Monitors — for many applications now served by gyros.

Pressure Switches — actuated by static pressure, differential pressure, rate of change of static pressure, rate of climb or descent, etc.

Motors — miniature, special purpose, including new designs with integral gear heads.

SPECIAL TEST EQUIPMENT

optical and electromechanical for flight test observations.

Please write us concerning your specific requirements in the field of missile or aircraft control and guidance.

Technical bulletins are available on most of the devices mentioned.

kollsman INSTRUMENT CORPORATION

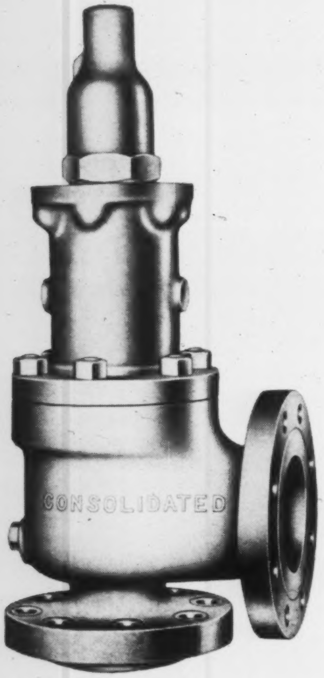
80-22 45th AVE., ELMHURST, NEW YORK • GLENDALE, CALIFORNIA • SUBSIDIARY OF *Standard* COIL PRODUCTS CO. INC.

For more information circle **34** on inquiry card.

NOW...CONSOLIDATED SAFETY RELIEF VALVES

in economical "2 in 1" design

Peak performance . . . positive valve action assured . . . even where discharge lines are long, or low "superimposed" back pressure exists in the relieving system.



"Two-In-One" design, improved performance . . . the new Consolidated Safety Relief Valve is the result of over 4,000 flow tests in 5 years at West Edmond, Oklahoma. At the A.S.M.E.-approved testing station there, natural gas is available in flow capacities up to 35,000 cfm and pressures up to 500 psig. The A.S.M.E.-approved conditions, apparatus, and procedures permitted Consolidated engineers to test-develop and prove the full range of valve sizes and pressures in both Standard and Bellows designs.

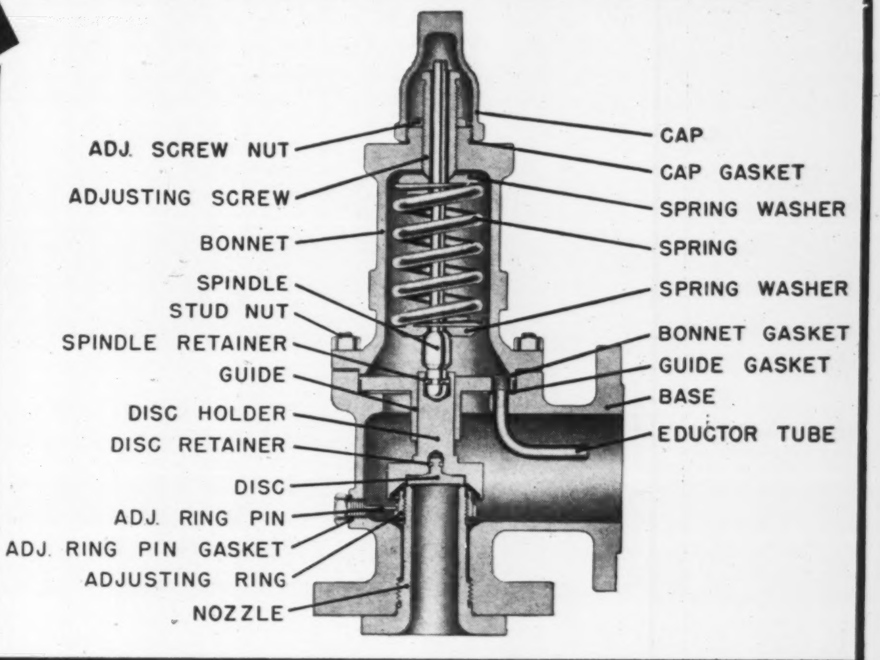
Interchangeability is so highly developed that the majority of Consolidated Standard Valves can be converted to the Bellows design, in the field, simply by installing the bellows. Each type has fewer functional parts than other comparable safety relief valves. Standardization of inlet and outlet center-to-face dimensions permits interchangeability with a large proportion of the valves of other manufacturers. Incorporated is an optically-ground flat seating surface that contributes to easier, more economical maintenance.

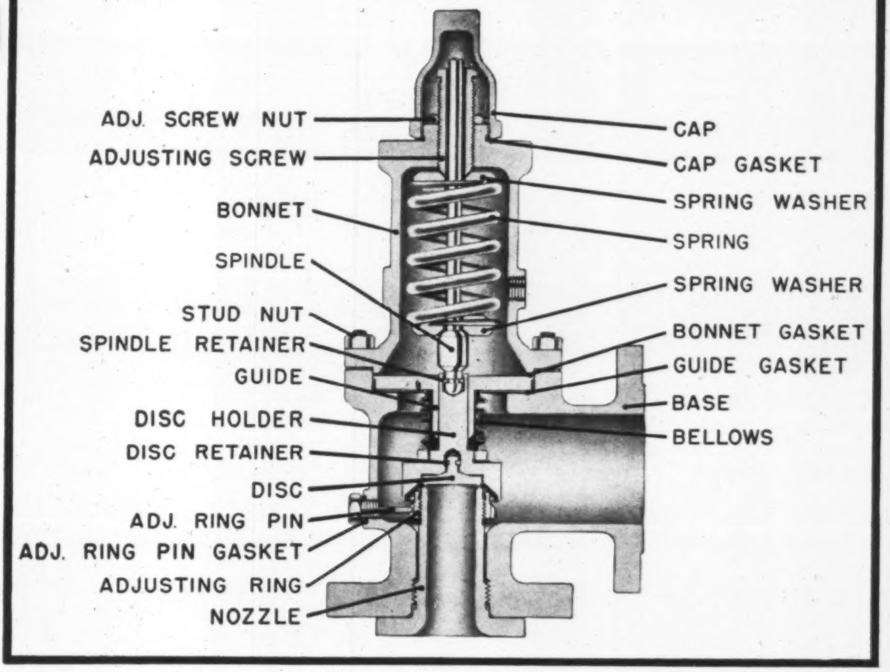
You can have the absolute protection and real economy of the thoroughly tried and proved Consolidated Safety Relief Valves for your plant today. Both Standard and Bellows types are available in sizes and pressures to meet requirements of the most advanced processing facilities. Write for full details. Ask for Catalog 1900.

CONSOLIDATED SAFETY RELIEF VALVES

For more information circle **35** on inquiry card.

STANDARD VALVE has an eductor tube that holds the pressure in the valve bonnet to approximately atmospheric pressure; thus only the force of the spring controls the valve. Valve action is improved and stabilized . . . repetitive flow capacity is provided . . . a new high in operational dependability is assured. Even under repeated popping of the valve, set pressure and blowdown are consistent. The valve will open to full capacity at 3% overpressure regardless of the position of the adjusting ring.


ADJ. SCREW NUT
ADJUSTING SCREW
BONNET
SPINDLE
STUD NUT
SPINDLE RETAINER
GUIDE
DISC HOLDER
DISC RETAINER
DISC
ADJ. RING PIN
ADJ. RING PIN GASKET
ADJUSTING RING
NOZZLE
CAP
CAP GASKET
SPRING WASHER
SPRING
SPRING WASHER
BONNET GASKET
GUIDE GASKET
BASE
EDUCTOR TUBE


ADJ. SCREW NUT
ADJUSTING SCREW
BONNET
SPINDLE
STUD NUT
SPINDLE RETAINER
GUIDE
DISC HOLDER
DISC RETAINER
DISC
ADJ. RING PIN
ADJ. RING PIN GASKET
ADJUSTING RING
NOZZLE
CAP
CAP GASKET
SPRING WASHER
SPRING
SPRING WASHER
BONNET GASKET
GUIDE GASKET
BASE
BELLOWS

BELLOWS VALVE is like the Standard but has a durable, two-ply stainless steel sealing bellows which effectively isolates from the valve's working parts any contaminants, corrosion, or viscous fluids. The bellows is balanced with the seating surface: set pressure of the valve is not affected by back pressure, whether constant or variable. Consequently, smaller discharge piping can be used, thus reducing the cost of pressure-relieving systems.

Certified and Approved

Both Standard and Bellows Valves are approved under A.P.I.-A.S.M.E. Unfired Pressure Vessel Codes, A.S.M.E. Unfired Pressure Vessel Code and are certified by the National Board of Boiler and Pressure Vessel Inspectors.

1879 CONSOLIDATED U.S.A.

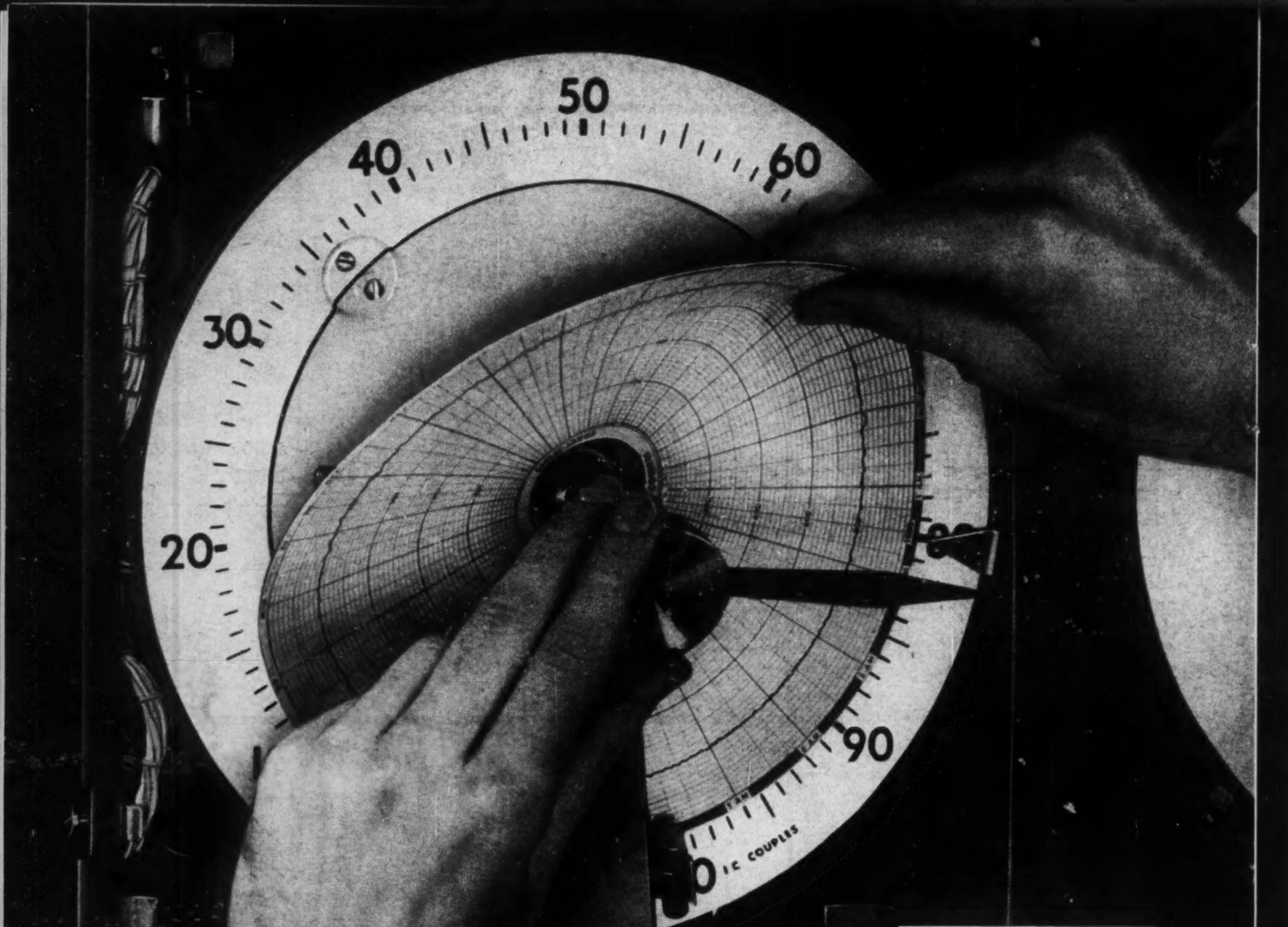
A PRODUCT OF MANNING, MAXWELL & MOORE, INC.

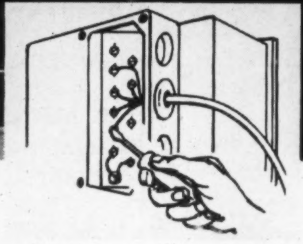
TULSA, OKLAHOMA

MAXWELL MANNING M&M MOORE INC. TRADE MARK

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

For more information circle **35** on inquiry card.





To put in operation, simply connect leads to back of case . . .

A new concept in . . .

operating ease

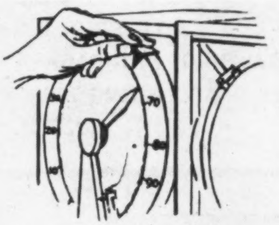
WITH SPEEDOMAX® H

Although this round chart Speedomax H is small in size, you can set the control point or read it from a distance almost as easily as "big" instruments. For the easy-to-see control and indicating pointers travel around a large 23-inch scale. Chart changes take less than a minute!

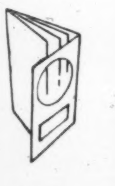
All wiring connections are made to an external terminal board, at rear of the case. If you move the instrument from job to job, range changes can be made on the spot. A screw driver is the only tool you need.

Whether you're using a simple indicator or a 3-action controller, all components are in one compact unit. Relays, amplifiers, etc., have plug-in connections.

In short here's a complete line of null-balance potentiometers available for a broad-range of temperature measurements including many now being made with non-potentiometer instruments.



. . . set control point setter
. . . turn on power switch.



To see the features of this new line, get our pictorial fold-out. Phone your nearest L&N office or write us at 4955 Stenton Ave., Phila. 44, Pa. and ask for Die-Out ND46(1).

LEEDS & NORTHRUP

instruments · automatic controls • furnaces

Editorial...

INSTRUMENTS and AUTOMATION

LAST month your editor reported briefly on the National Conference on Automation sponsored by the CIO Committee on Economic Policy. We reported that the generalizations spoken by the automation-industry spokesmen suffered in comparison with the *facts* offered by the CIO spokesmen about the growth of unemployment in *expanding* automated industries in 1954. The impression was left that automation can or might cause severe technological unemployment (if it is not already so doing)—and the climax of the Conference was reached by Senator O'Mahoney when he said: "The entire population of the United States now has the opportunity to see clearly that the pushbutton industrial system has such widespread effects upon our whole social, economic, and political structure that a Congressional study is unavoidable." So now the inflammable exaggerations about automatic control have indeed aroused the entire population—and its government.

The Hon. Joseph C. O'Mahoney (D., Wyo.) seems to have a propensity for "antimachine" activity. In commenting favorably on Minnesota Senate Bill No. 209 in the year 1939, Senator O'Mahoney said "one tax proposal to reduce unemployment that has been made is known as a labor-differential tax. This is a tax on the value added in the manufacture of an article except for that assignable to labor. The purpose is to stimulate the use of labor relative to the amount of machinery in the manufacture of goods." Senator O'Mahoney favored this bill to tax "labor saving" machinery in the year 1939 and, apparently, still fears technological progress.

We recognize that this fear stems from a desire to aid the laboring man, and we concur with the Senator's and the CIO's humane efforts to see that human beings are not made unemployed by machinery or automatic controllers. Their intentions are of the best. But taxes on machinery, investigations of automation, or any activities designed to retard technological improvement never have and never will solve primarily economic problems. Like all other problems, nothing effective can be done unless the *causes* of the problem are attacked. Finding the cause of a problem is known as rationalization of the problem—and to date most of the talk on the economic aspects of automation has been completely irrational in the sense that effects are being treated as causes.

The following comments, made by your editor at the recent annual meeting of the American Industrial Arts Association, Atlantic City, April 27, 1955, were intended to help rationalize the problem, to define automation in useful terms for the teacher (or investigator), and to put the economic problems in a little better perspective. It is hoped that these remarks will do something to prevent a Congressional investigation of the wrong thing, a pursuit by a Congressional committee up a blind alley, a waste of taxpayers' money.

Automation and Economics—

A Counterattack on Anti-automation Propaganda

by M. H. Aronson

I WELCOME this opportunity to speak to members of the American Industrial Arts Association for several reasons: (1) Automation is as much an art as a science, (2) there is a growing need for technicians who can practice the art of automation, (3) supervisors of industrial-art curricula are one of the few groups who can do something constructive by examining automation, and (4) entirely too much has been spoken and written about automation that is out of touch with reality. I hope to debunk several widely accepted ideas.

Definition of Automation

It is common practice for each speaker on automation to start out with "there is no accepted definition of automation; everybody has his own idea." This is nonsense.

Automation is but a short word for AUTOMATIC CONTROL—and everybody knows what automatic control means. Like a host of other words in the English language (such as engineering, mathematics, medicine, or industrial arts), the term "automation" is a horizontal word embracing many facets. Automatic control can be applied to a lathe, a distillation tower, an elevator, an inventory. There is no more reason for saying that automation has different meanings because some think of automatic control of offices while others think of automatic control of plants, than there is to say that mathematics has no meaning because some math teachers teach geometry while others teach calculus. Automation means automatic control.

A Specific Definition

Recognizing that a bit more definiteness could be of value, I proposed the following definition of automation in 1954: "Automation is the substitution of mechanical, hydraulic, pneumatic, electric, and electronic devices for human organs of decision and effort." This definition does two things—it tells that the devices used are of many types—NOT just electronic or mechanical; it also tells that the purpose of the device may be either to "arrive at a decision" or "make an effort." This definition precludes any attempt to "prove" that automation does not displace any labor. *Automation is designed to displace routine, onerous, dangerous, menial and trivial labor, mental or physical.* Automation spokesmen will do well to stop trying to prove that (in the short-run, at least) automation does not displace any labor. They will convince nobody but the already convinced, and there is too much factual evidence to prove that displacement can and does occur, as indeed it must.

Specific Fields of Automation

We have established the devices and functions of automation. Next, let us see if we can subdivide this all-encompassing group of devices (which includes almost everything used in engineering, science, physics and chemistry) into smaller units susceptible for study by, let us say, curricula directors. Are there any cohesive parts of the field with common problems, common devices, and a common language? Fortunately, there are:

1. Plants, or continuous-process manufacturing facilities for petroleum, paper, foods, steel, etc.

2. Factories such as fabricators, engine plants, auto body factories, machine shops, etc. Perhaps we can call these piece-part factories as contrasted with the continuous-flow plants. Automation in this field often is called "Detroit automation."

3. Offices—including retail, accounting, inventory, wholesaling, data processing.

4. Computation—including scientific and engineering calculations.

It is admitted that some overlap occurs, but each of these fields has different problems, uses different automation devices and different terminologies, and can be considered a distinct field for automation.

Every speaker on the subject of automation should start out with which of these fields he has in mind—because *very little applies to all of them at one time.* In considering automation it is essential to establish that you are trying to analyze or meet the needs of one or more of these fields. This will prevent the now common dissipation of energy in omnidirectional generalizations with no power on any specific point. Unless the speaker on automation defines his field, he is merely generalizing—and generalities, no matter how interesting, are often worthless.

Devices for Each Field

What specific devices are used for automation in these specific fields?

Process Industries

The process industries are the most advanced in the use of automatic techniques. Entire refineries have been operating for years with *direct labor* forces of less than a dozen men. The average unit refinery operation requires only one or two operators. The valve, controller, and pickup for temperature, pressure, level, etc., are the basic and standard instruments in this field.

The newest developments in this field are (1) competition between conventional pneumatic techniques and newer electronic controllers for accomplishing essentially the same functions, and (2) more extensive use of digitized-type data handling. Many exciting new instruments become available each month—more than 200 are reported each month in the magazine *Instruments & Automation*—but *none, individually or collectively,* can be considered any threat to the already small *direct labor* force required to operate continuous processes.

The electronic computer, so often talked about as the heart of the automatic plant of tomorrow, is not even being experimented with as a process controller. However, the analog computer (essentially a system analyzer) offers great promise in analyzing operating systems to attain greater efficiency—and both analog and digital computers are becoming standard tools in process design work. Note that this is *not* labor-eliminating control.

Hence the field with the most advanced automation is not using computers as controllers, is not changing its character, and is not experiencing any change commensurate with the talk about automation.

Piece-part Industries

The piece-part industries use machine tools, motors, and assembly lines (rather than the pipes, fluids, and valves of the process industries). Here the advent of the multi-station and transfer machine, plus automatic handling of the parts between the machines, are the new developments—and are probably the developments which have so inflamed the interest in automation today. Yet the piece-part industries use little or no complicated feedback control systems. Except for a few experimental machines, no computers are controlling lines or individual machine tools. Only the largest manufacturers can afford the transfer-type machine tools. The few manufacturers who have made the multi-million-dollar investment have not decreased their labor forces. The only really new developments are the transfer-type machine tool and the still-experimental computer-controlled lathe—a small excuse for all the noise. It must be admitted that these automatic machine tools require less direct labor than their manual predecessors; they also require more skilled maintenance men.

Business

The third field is business—payroll, inventory, etc. Here digital data processors displace clerks performing routine calculations. But the computers cost from 10 to 200 thousands or more dollars—only the larger firms can use them, perhaps ever. And there is little evidence, even where they are being used, that clerk displacement is occurring. Our investigations have revealed that firms such as GE are using their data processors not only to perform their routine tasks, but also to perform many tasks previously impossible by manual clerical labor.

Scientific and Engineering Calculations

The fourth specific field is the essentially design and mathematical one of engineering calculations. Here is where the computers, so often described in terms of the manless plants of tomorrow, have found their major applications to date. Computers have become powerful tools in the hands of design engineers and mathematicians. But the scarcity of such personnel is so acute that discussion of the labor-saving implications of automation devices in this field is of no value.

Whenever we hear claims about automation devices replacing large numbers of employees, in any of the four specific fields, we try to get the facts from the company involved. We have found, time after time, that the installation of new controllers or new data processors permitted the company to do a bigger and better job—and that the number of employees involved in the specific department was not reduced. *Yet we do not mean to try to establish that automation devices do not displace labor;* they are designed to displace labor involved in routine, onerous, dangerous, menial and trivial tasks. The problem that now needs discussion is WHAT IS THE ROLE OF AUTOMATION IN THE OVER-ALL ECONOMIC PICTURE?

Automation and the Economy

The economic problems cannot be disposed by citing generalities, by pointing out long-term trends, by reminding the listener of the buggy-whip industry, by simple platitudes. The growth of the telephone industry since the introduction of the automatic telephone dial system does not answer why, in 1954, the Bell system alone laid off 17,000 workers (according to Joseph Beirne, Pres., Communication Workers of America-CIO) while *expanding* their number of telephone installations.

The issue has been joined, in conference after conference, in editorial after editorial, on the subject of WILL AUTOMATION CREATE A SICK OR A HEALTHY ECONOMY? IS AUTOMATION A BOON OR BURDEN? This issue has been talked about so much that everyone now accepts it as an issue, even our legislative leaders. Before we enter these economic matters, let us examine a few basic, obvious, economic facts of life.

Economic Facts

The relation between automation and the economy must be analyzed only after consideration of the following *facts*:

1. The economic health of our nation rests on economic policies that includes tax rates and policies, federal expenditures, price/wage ratios, bank policies, bond rates, stock values and dividends, and other economic factors.

2. These economic factors establish the degree of purchasing power and market demand—which in turn establishes the degree of consumption of the output of our economy.

3. Automation is but one of many technological developments leading to increased productivity.

4. A healthy economy will consume its productive output and retain still greater demand with unemployment well below the inevitable minimum of a few percent of the total workforce available.

5. A sick economy has economic troubles, with or without automation. These economic ills include inability to consume the output of the economy, growing inventories, growing unemployment.

6. Sickness in the economy must be attacked at its sources—which are the economic factors that establish the purchasing power of the people in the country. The only alternative to increasing purchasing power is to decrease productivity, a reactionary and dangerous approach.

These facts show clearly that automation cannot establish the basic economic health of the nation—although it might aggravate economic ills by increasing productivity at a time of economic decline (synonomous term for diminished or inadequate purchasing power). Conversely, the degree of economic health and stability will definitely affect the degree of automation attained—because there will be little effort to increase productivity at a time of economic decline.

Hence, automation has no direct economic implications. It cannot make a sick country healthy or a healthy country sick. *It can make a healthy economy still more healthy —and it might conceivably make a sick economy more sick. But it cannot be a fundamental cause for economic stability or instability.*

Such cause must be found in the inter-related action of the many economic factors already at work in our free capitalistic society. These are the factors that need investigated, analyzed, understood. But what Senators are now investigating the economic factors that make up the "market" in our free society? Our nation has exhibited remarkable stability, economically, for the past few years. Why are not the reasons for this stability now under investigation? Can or should any radically new ideas be considered before we know and understand what we already have?

This is a call to arms to attack the roots of the economic problem that faces our nation. Economic maladjustment has appeared in several areas. We urge Senator O'Mahoney or other Senators to set up a committee to study purchasing power, to evaluate the economic factors that enter into the over-all production-consumption-employment cosmos. Investigations of automation, or even conferences on the economic effects of automation, not only waste the time and effort that should be directed at the economic causes of economic maladjustment but are even worse—they lead to the development of automation as a scapegoat, a whipping boy. We in the automation field must refuse to permit ourselves to be considered as the economic determinates in our economy; we must counterattack and insist on solving the economic problems at their roots.

In conclusion, the major premise of this discussion has been that increasing productivity demands increasing purchasing power—but that the problem of increasing purchasing power requires consideration of the economic factors that establish the market demand, whereas investigations or discussions of the "economic aspects of automation" are fruitless and diversionary antimachine-type activities.

To do as many are doing today, which is to welcome automation verbally while discussing (and thus pointing to) automation as the possible cause of economic trouble, is unconscious but demonstrable hypocrisy. These people should indeed welcome automation as one of the many factors making for increased productivity—but their fingers should point to our economists and legislators when markets shrink and unemployment grows.

New Instruments...

INSTRUMENTS and AUTOMATION

CONTENTS OF THIS DEPARTMENT

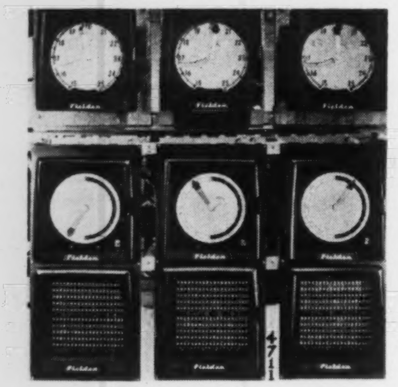
Process Monitoring and Control ... 896
Pressure ... 899
Flow Rate and Volume ... 900
Temperature ... 900
Force, Vibration, Displacement, etc. ... 902
Laboratory ... 904
Counting, Data-handling, Computing ... 908
Mechanical Gaging and Testing ... 910
Electrical Testing ... 914
Electrical Instruments ... 916
Electrical Instrument Accessories ... 923
Amplifiers and Power Supplies ... 924
Electrical and Electronic Components ... 930
Electromechanical Components ... 934
Mechanical Components ... 938
Valves ... 941
Miscellaneous ... 943

For further information use the postage-free order card on page 1017

PROCESS MONITORING and CONTROL

Process Monitor

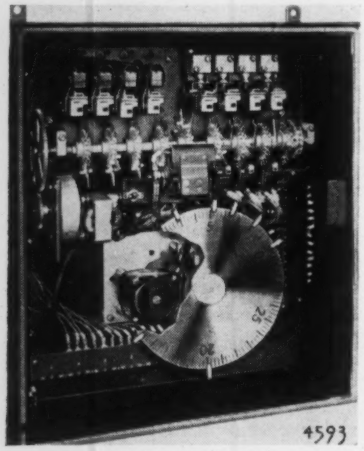
New "Indicating Scanner" makes it possible to test and control continuously an unlimited number of industrial process variables from a single point. Variables include level, temperature, thickness, weight, pressure, etc. Scanner performs functions usually requiring many instruments. Illustration shows three 76-point scanners.—*Fielden Instrument Div., Robertshaw-Fulton Controls Co.,* 2920 *N. 4th St., Philadelphia* 33, *Pa.*



For more information circle **201** on inquiry card.

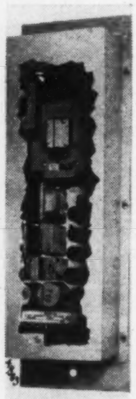
Process-program Controller

New "Flex-O-Timer" features direct time settings on a large dial and pins set at corresponding intervals in step discs; comprises a motor-driven time-measuring device and an independently-driven step-disc mechanism controlling operation of one to eight electric or pneumatically operated functions. Each function can be carried through an aggregate of 20 on-and-off steps.—*Taylor Instrument Companies, Rochester* 1, *N. Y.*


4593

For more information circle **202** on inquiry card.

D-c.-to-air Converter



New "EMF/Pneumatic Transmitter" converts electrical measurements of temperature, speed, pH, etc., into proportional 3-15-psi. pneumatic outputs; is easily mounted on back of a control panel. Feature: inverse feedback equal to 99.8 percent of input signal, minimizing amplifier variations and maximizing stability. Standard spans as narrow as 10 mv. and as wide as 60 mv. (wider spans available). Sensitivity 0.05 percent of scale; accuracy 1 percent, repeatable to 0.25 percent. For a full-range step-function input, output signal will change from 3 to 15 psi. (or vice versa) in 4 seconds or less.—*The Foxboro Co., Foxboro, Mass.*

For more information circle **203** on inquiry card.

Control Initiator

New control initiating instrument for switchboard or panel instruments is an automatic, all-electrical device for initiating action when a predetermined value is reached. System electrically picks up signal from instrument pointer. No mechanical contacts.—*General Electric Co., Schenectady* 5, *N. Y.*

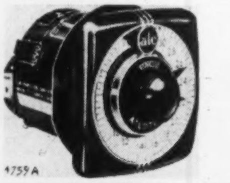
For more information circle **204** on inquiry card.

Control-initiating Relays

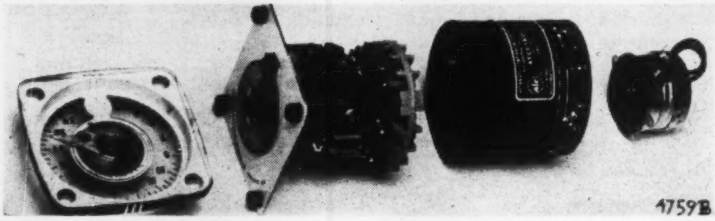
New line of air relays can perform functions such as air volume amplifying; pressure reversing, retarding, advancing and averaging; differential controlling; and minimum pressure controlling. (Illustrated: averaging.) Control in most cases is gradual; snap

AVERAGING RELAY
MFD BY
THE POWERS REGULATOR CO.
CHICAGO NEW YORK
4449

Automatic-reset Process Timer

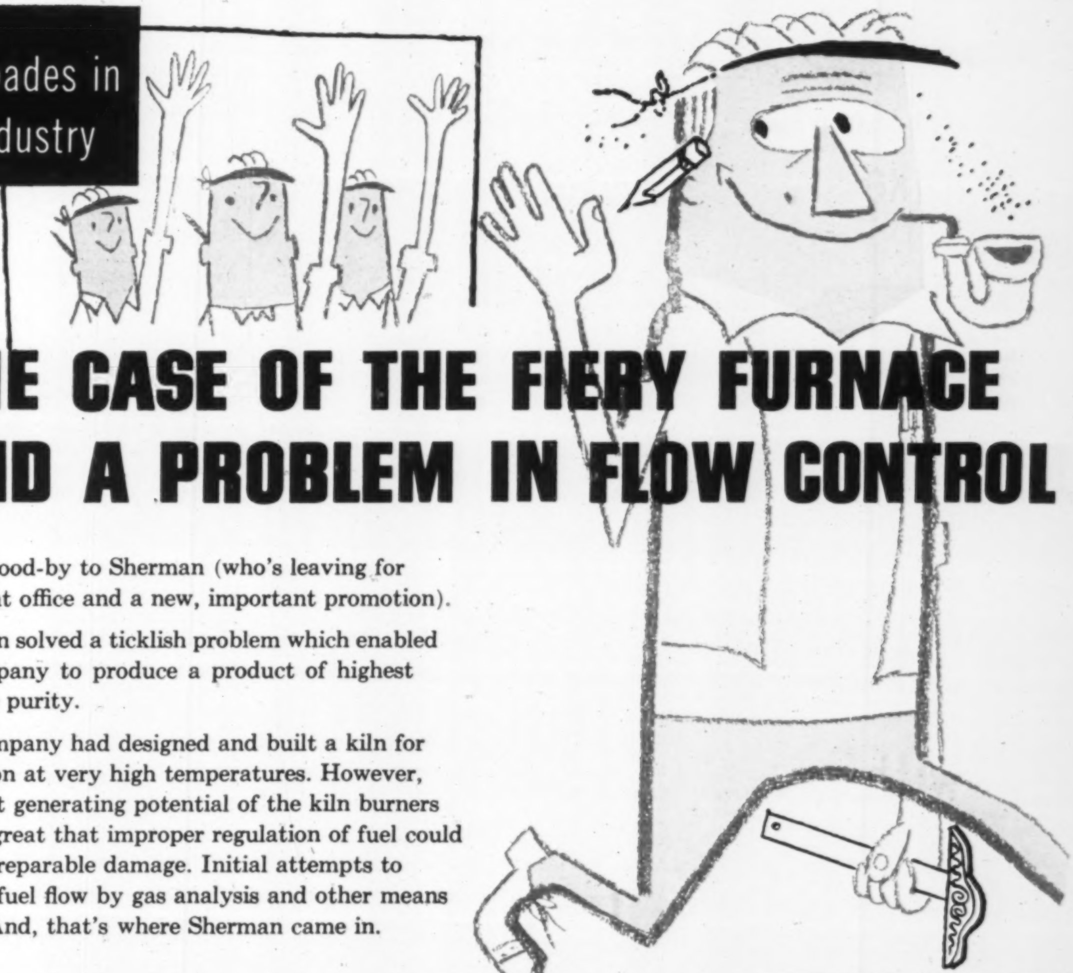

4759A

New "Atcotrol" mounts into cutout 3-3/16-in. diam. Design makes possible quick external inspection of timer motor operation, clutch engagement, elapsed time pointer operation, pointer reset and load switch actuation, without interrupting operation or process. Full internal inspection claimed possible in 2 sec. while operating. Self-cleaning contacts, easily interchangeable in field, are rated at 10 amps. 115 v.ac. non-inductive. Interchangeable dials and motors make possible 10 timing ranges from 0-to-15 sec. with minimum setting of ¼-sec., to 0-to-240 min. with minimum setting of 240 sec. Dial and motor can be changed in about 3 min.—*ATC Co.,* 5200 *Pulaski Ave., Philadelphia* 44, *Pa.*


4759B

For more information circle **205** on inquiry card.

S/K apades in industry



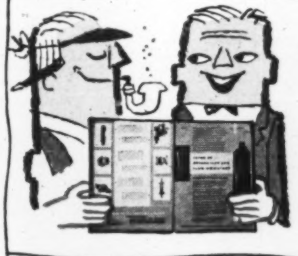
THE CASE OF THE FIERY FURNACE AND A PROBLEM IN FLOW CONTROL

Wave good-by to Sherman (who's leaving for the front office and a new, important promotion).

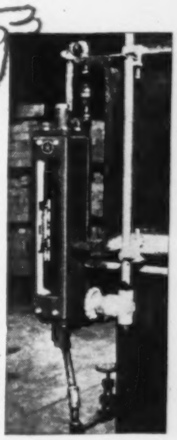
Sherman solved a ticklish problem which enabled his company to produce a product of highest possible purity.

The company had designed and built a kiln for operation at very high temperatures. However, the heat generating potential of the kiln burners was so great that improper regulation of fuel could cause irreparable damage. Initial attempts to control fuel flow by gas analysis and other means failed. And, that's where Sherman came in.

Sherman remembered reading an article which offered a condensed bulletin on all types of SK Rotameters—accurate, variable area instruments for measuring and controlling fluid rate of flow.



He sent to SK for a copy of Bulletin 18-RA, checked the types of meters described, found a Rotameter to be ideal for the purpose, and called in a specialist—his nearest SK Sales Engineer.



SOLVED THE PROBLEM NEATLY!

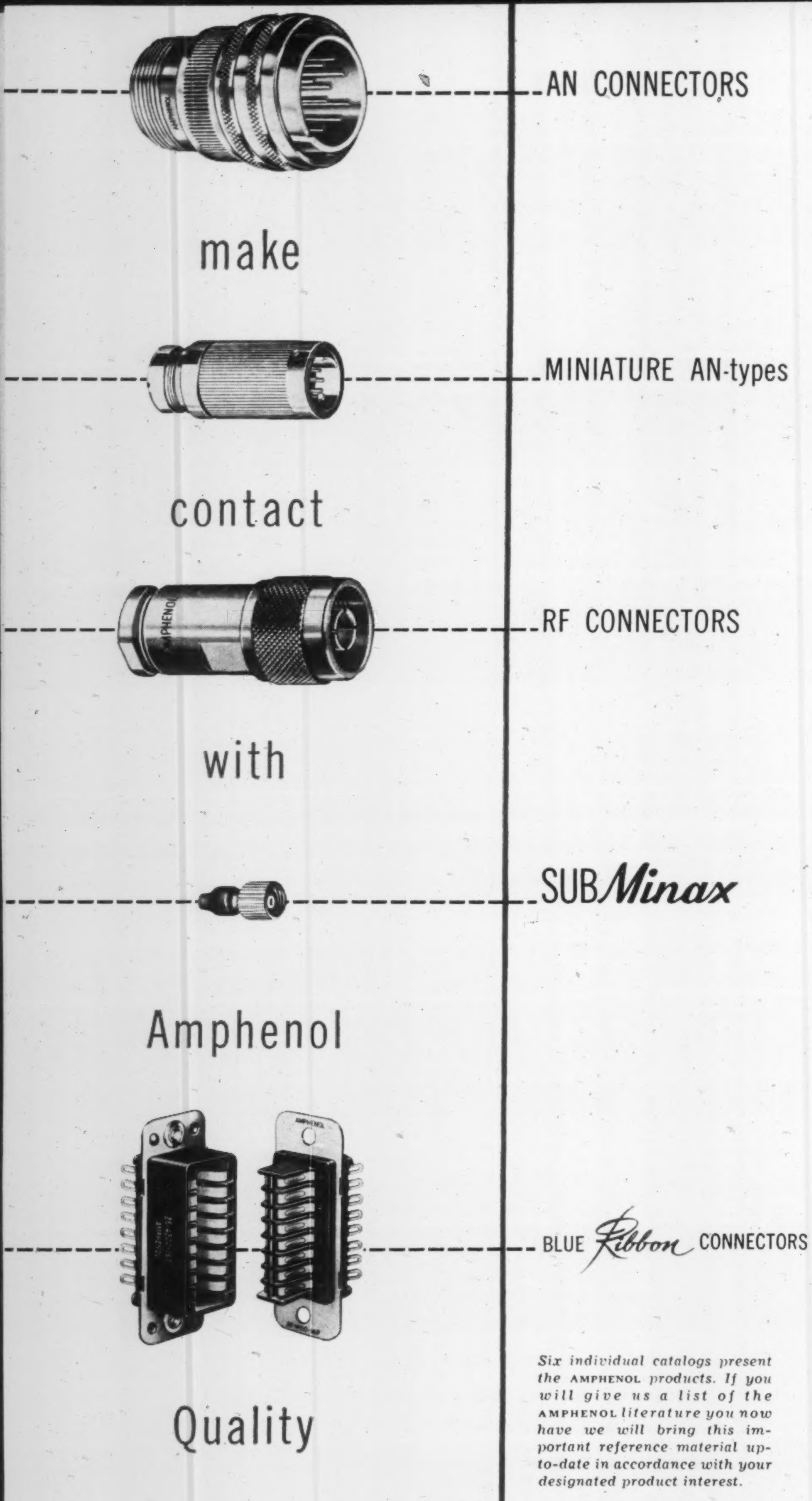
An SK Safeguard Rotameter is used to measure the flow of fuel oil to the burners. In operation for some time, the Rotameter has protected the equipment against damage, saved the operator time, and even helped save some fuel by providing simple and accurate rate of flow measurement.

MORAL! *Request a copy of Bulletin 18-RA for your files. Make use of a qualified specialist, your nearest SK Sales Engineer.*

Schutte and Koerting
COMPANY
MANUFACTURING ENGINEERS
2225 STATE ROAD, CORNWELLS HEIGHTS, BUCKS COUNTY, PA.

Jet Apparatus • Heat Transfer Equipment
Strainers • Condensers and Vacuum Pumps
Oil Burning Equipment • Rotameters
Flow Indicators • Radiafin Tubes • Valves
Spray Nozzles and Atomizers • Gear Pumps
Desuperheaters

For more information circle **37** on inquiry card.



AN CONNECTORS

make

MINIATURE AN-types

contact

RF CONNECTORS

with

SUB*Minax*

Amphenol

BLUE *Ribbon* CONNECTORS

Quality

Six individual catalogs present the AMPHENOL *products. If you will give us a list of the* AMPHENOL *literature you now have we will bring this important reference material up-to-date in accordance with your designated product interest.*

AMERICAN PHENOLIC CORPORATION
CHICAGO 50, ILLINOIS
In Canada: AMPHENOL CANADA LTD., *Toronto*

AMPHENOL

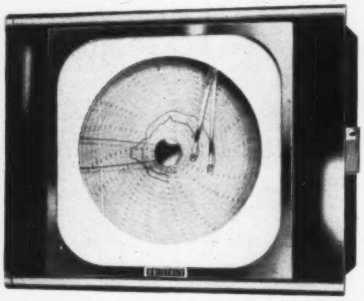
For more information circle **38** on inquiry card.

action available in some devices. Direct or reverse action is standard option on many relays.—*The Powers Regulator Co., Skokie, Illinois.*

For more information circle **206** on inquiry card.

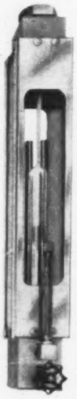
Two-pen Recorder

New 12-in. round-chart "Electronic Dynamaster" recorder can make two continuous records at the same time.



It is of the automatic self-balancing potentiometer or bridge type and its applications include taking wet and dry resistance bulb temperatures, Btu and temperature differentials, and speed of rotation from two different points on a machine.—*The Bristol Co., Waterbury 20, Conn.*

For more information circle **207** on inquiry card.



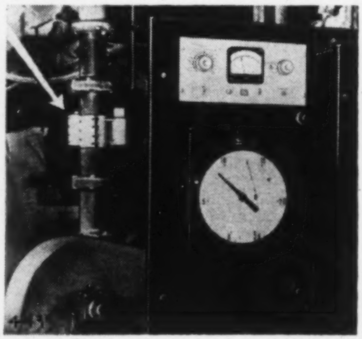
Specific-Gravity Indicator

New "Spee/Gee" specific-gravity indicator is designed for continuous sampling and other processing service. Position of "Non-Spin" hydrometer in special enclosure indicates fluid specific gravity; may be read at all times; is suitable for panel mounting. —*Brooks Rotameter Co., Lansdale, Penna.*

For more information circle **208** on inquiry card.

Density Gage

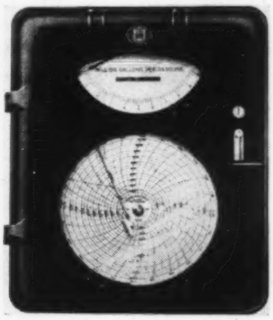
New "PS Series" permits percent by weight of solids or liquids in slurries to be readily measured and controlled. Principle: use of radioactive absorption and "Ohmart Cells" as measuring means. All measuring components are outside pipe or vessel.—*The Ohmart Corp., P. O. Box 67, Sta. B, Cincinnati 22, Ohio.*



For more information circle **209** on inquiry card.

Electrical Transmission

New "Orthoflow" is electric transmission system utilizing two wires for transmission of flow, liquid level, or pressure. Transmitting units may be applied to mercury cylinders of varying sizes to produce measurements over 4 to 1, 10 to 1, 13 to 1, 18.5 to 1, and 20 to 1 ratios with accuracies not exceeding plus or minus 2 percent at any point over these ranges.—*Simplex Valve & Meter Co., 7 E. Orange St., Lancaster, Pa.*



For more information circle **210** on inquiry card.

Computer Controller

New "Integrating Computer Model 6055," for process and quality control, is a dual section analogue computer: one section computes integral of square (or mean square) of an a-c. or d-c. input voltage; other section computes integral (or mean) of a-c. or d-c. input voltage. If current is analog of a thickness, density, etc., instrument can compute standard deviation of process; provides electrical analogs for controlling process. Integrating time base is adjustable from 1 sec. to 180 sec.—*Cedar Engineering Inc., 5806½ W. 36th St., Minneapolis, Minn.*

For more information circle **211** on inquiry card.

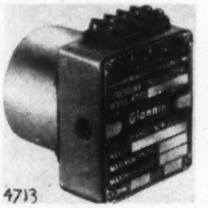
Automatic Gasoline Blending Monitor

New "Automatic Reid Recorder" monitors blending of motor gasolines to obtain the most economical ratio of butane to base stock; minimizes ethylization costs; reduces reblends and operating tankage needs; makes in-line blending practical for even small refineries; reflects any change in vapor pressure within 3 min. and will stabilize at a new level within 8 min. after receiving a quantity of high or low R.V.P. material.—*Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.*

For more information circle **212** on inquiry card.

PRESSURE

Pressure Transmitter



New "Model 47155" for industrial applications requiring an electrical output proportional to pressure is an improved, low-cost version of maker's pressure transmitters used in aircraft and missile applications. Ranges up to 100 psia., psig. and psid. Outputs up to 40 volts can be obtained and transmitter be used to operate indicating, recording or control devices with little or no amplification.—*G. M. Giannini & Co., 918 E. Green St., Pasadena 1, Calif.*

For more information circle **213** on inquiry card.

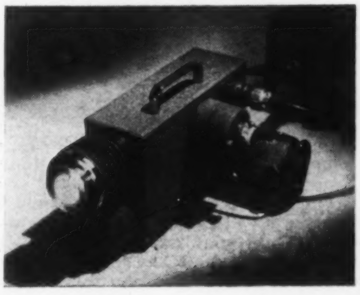
Absolute-pressure Switch

New "Type J20" utilizes a spring-loaded evacuated bellows to respond to source pressure variations independent of atmospheric pressure and temperature; can be factory set anywhere between 0 and 35 psia. with a differential from 1.5 to 5.0 psi. Adjustable range 5.0 psia.; repeat accuracy 0.1 psia. Switch rating 4 amps. 28 v.dc., 10 amps. 115 v. ac.—*United Electric Controls Co., 85 School St., Watertown, Mass.*

For more information circle **214** on inquiry card.

Pressure Transient Recorder

New "Model 216" pressure-transient recorder uses interferometric optical principles to record short-term pressure variation on film. First approximation of pressure is available

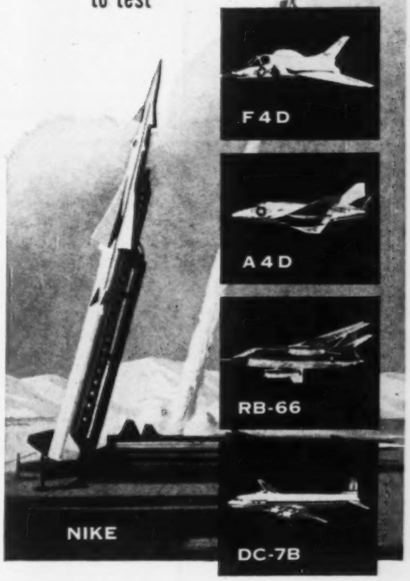


Do you
think about
Angular
Acceleration?

DOUGLAS

does...

and uses Statham
Angular Accelerometers
to test



Statham unbonded strain gage liquid rotor angular accelerometers offer a simple, reliable means for the study of the rotary motion of a test body under conditions where a fixed mechanical reference is not available. For static and dynamic measurements in ranges from ±1.5 to ±3,000 rad/sec², four standard models are offered.

Please request Bulletin AA2.

Statham
LABORATORIES
LOS ANGELES 64, CALIFORNIA

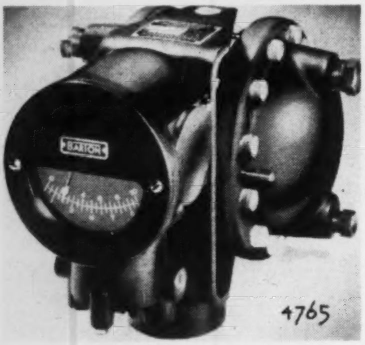
For more information circle **39** on inquiry card.

by simple counting of number of fringes. System comprises (1) combined transducer, optical system, and camera with 2-millisecond timing-pip system, (2) control unit which can be located remotely, for control of camera drive motor, dynamic braking system, and monochromatic light source which illuminates transducer.—*Beckman & Whitley, Inc.*, 1099 *E. San Carlos Ave., San Carlos, Calif.*

For more information circle **215** on inquiry card.

Differential Pressure Pneumatic Transmitter

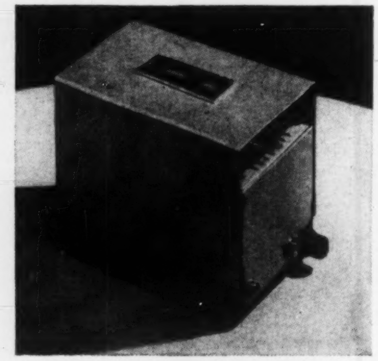
New "Model 214" is claimed to transmit flow, liquid level, and/or differential pressure at a high speed of response with low air consumption. Adverse conditions, such as wide ambient temperature variations, rapid fluctuations in flow, mechanical vibration of lines and severe over-loads will not impair accuracy because of rupture-proof differential measuring unit.—*Barton Instrument Corp.*, 1429 *South Eastern Avenue, Los Angeles* 22, *Calif.*



For more information circle **216** on inquiry card.

Pressure Transmitter

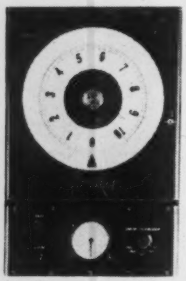
New "Type 1100," for applications where output voltage is to be a non-linear function of pressure, comprises a precision ruggedized voltage divider having taps and provision for resistance loading across winding.—*Trans-Sonics, Inc., Bedford Airport, Bedford, Mass.*



For more information circle **217** on inquiry card.

FLOW RATE and VOLUME

Flowmeter Calibrator



New "Flowmeter Calibration System" based on time and weight measurements is specially designed indicator-controller in which electrical indications of weight from load cell start and stop a timer automatically. Illustrated instrument is for use with a 1000-lb. precision-type load cell.—*Baldwin-Lima-Hamilton Corp., Philadelphia*, 42, *Pa.*

For more information circle **218** on inquiry card.

Flowmeter Calibrator

New "Type 350" fuel flowmeter test stand, for calibrating fuel flow transmitters in range from 100 to 12,000 gph, consists of a single integral unit incorporating a fuel supply tank, fuel weighing system with automatic electrical interval timer, control panel, serviced rate of flow indicators, pump, filter, fuel refrigerating system, and necessary power supplies.—*Bone Engineering Corp.*, 701 *W. Broadway, Glendale* 4, *Calif.*

For more information circle **219** on inquiry card.

Predetermined-quantity Explosion-proof Meter

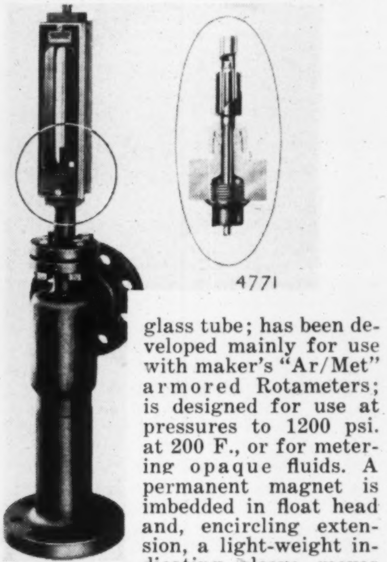
New explosion-proof model of "Electricontact Meter" with electric shutoff, for measuring liquids in hazardous atmospheres, comprises a standard "Niagara" meter plus a register containing an electric switch designed to complete an electric circuit after passage of a predetermined quantity of liquid through meter; incorporates "Model EX-AR Microswitch" which carries UL listing. A wide variety of register constructions is offered.—*Buffalo Meter Co.*, 2929 *Main St., Buffalo* 14, *N. Y.*

NIAGARA
BUFFALO METER CO.
POUNDS

For more information circle **220** on inquiry card.

Rotameter Extension

New "Mag/Na/Vue" indicating extension features a non-magnetic metal extension tube replacing customary glass tube; has been developed mainly for use with maker's "Ar/Met" armored Rotameters; is designed for use at pressures to 1200 psi. at 200 F., or for metering opaque fluids. A permanent magnet is imbedded in float head and, encircling extension, a light-weight indicating sleeve moves in response to change in float position. It is said that "virtually no friction exists."—*Brooks Rotameter Co., Lansdale, Pa.*

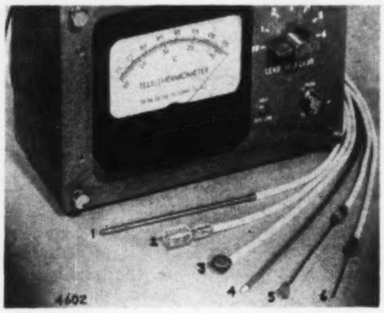


For more information circle **221** on inquiry card.

TEMPERATURE

Thermistor-type Probes

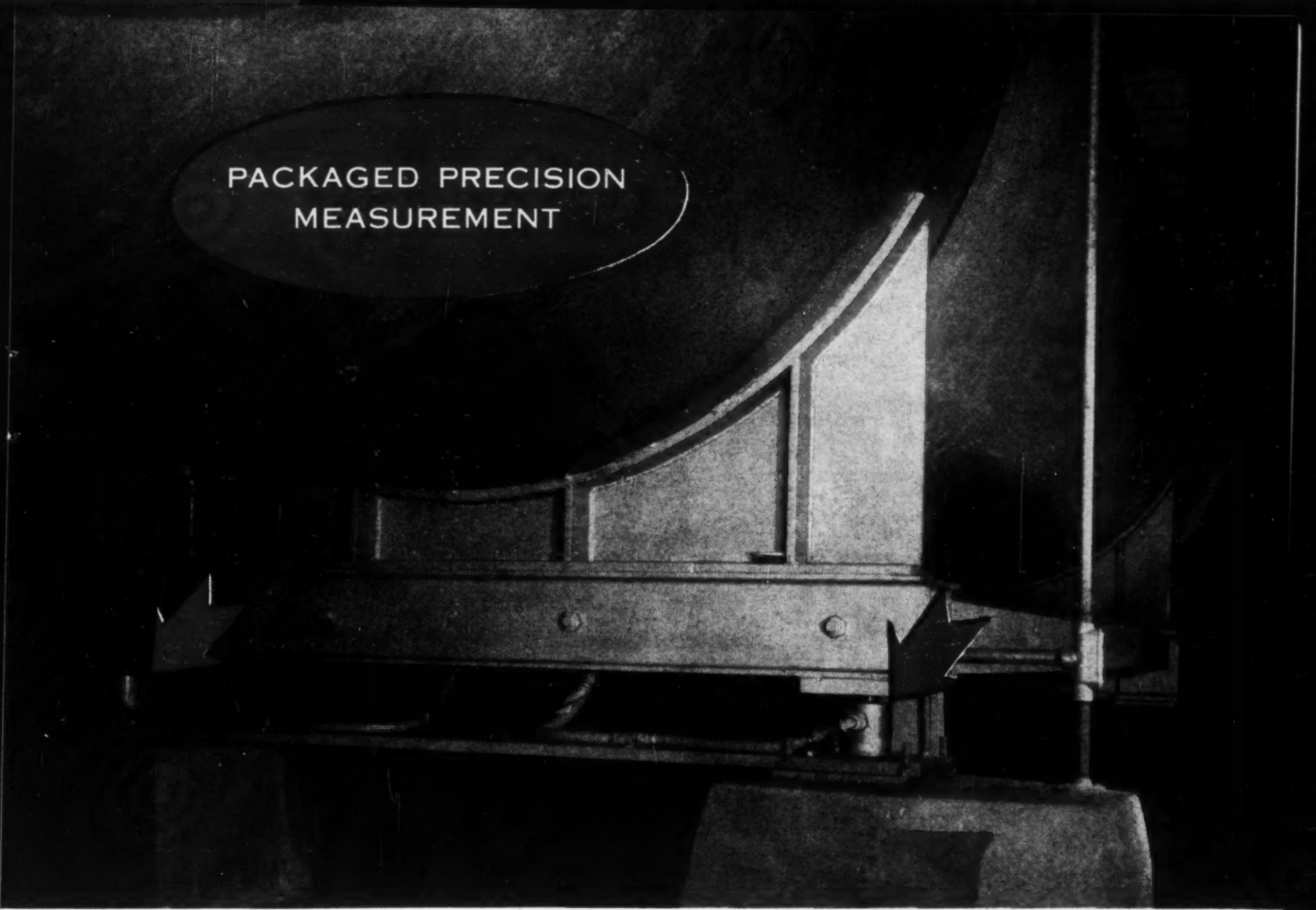
Six new probes increase versatility of maker's thermistor "Tele-Thermometer": (1) Fast stainless steel, (2) air temperature, (3) flat surface, (4) flexible immersion, (5) fast oral, (6) hypodermic. Typical 99-percent response times: tubular stainless steel and oral probes 4 sec., flexible immersion 35 sec., hypodermic 3 sec.—*Yellow Springs Instrument Co., Inc., P.O. Box* 106, *Yellow Springs, Ohio.*



For more information circle **222** on inquiry card.

Bearing-temperature Monitor

New bearing temperature monitor features internally shock-mounted and sealed contact-making indicators. Each trip point is adjustable from front. Any number of points can be monitored by a combination of panels. Normal range 0-300 F.; other ranges



Stanley Home Products, Inc. checks Freon losses as

Two tiny SR-4® Load Cells weigh 200,000 lb. tanks automatically

Baldwin's "Packaged Precision Measurement," neatly solved the handling of large volumes of Freon at the Stanley Home Products plant in Easthampton, Mass. A constant record of stored and used quantities was needed to avoid excessive leakage and evaporation losses.

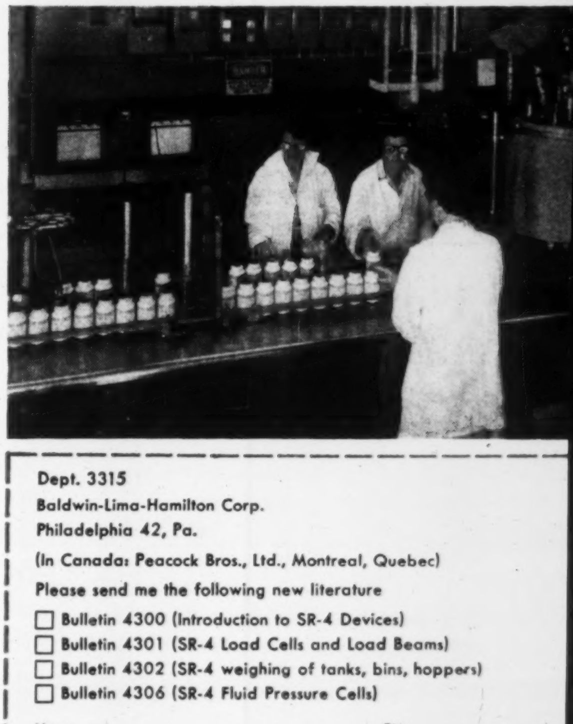
Continuous automatic weighing of their two 15,000 gallon storage tanks with Baldwin SR-4 Load Cells answered Stanley's problem perfectly. Two small SR-4 compression-type 50,000 lb. load cells were installed as supporting members on the concrete base at one end of each tank. These support exactly half the load of the 200,000 lb. tanks and the instruments are calibrated to read only the weight of the Freon in the storage tanks.

Reinforced flexible hose at inlet and outlet eliminates effect of connecting piping on weighing accuracy.

This Baldwin system gives Stanley weighing accuracy within ½ of 1% of scale (200,000 lbs.). Baldwin-engineered instrumentation provides remote indicators at the tank car siding and recorders at a centralized control panel. The weighing system controls a motor-driven pump at the siding, shutting it down automatically when the tanks have 13,500 gallons of Freon.

Packaged Precision Measurement can solve similar problems for *you*. For detailed information on SR-4 Device applications and instrumentation use coupon today.

Baldwin strip chart recorders on wall (lower photo) show rate of consumption of Freon. Recorders are connected by electrical cables to SR-4 Load Cells under one end of 15,000 gallon tanks on other side of wall (upper photo).



Eddystone Division

BALDWIN-LIMA-HAMILTON

For more information circle **40** on inquiry card.

Dept. 3315
Baldwin-Lima-Hamilton Corp.
Philadelphia 42, Pa.
(In Canada: Peacock Bros., Ltd., Montreal, Quebec)

Please send me the following new literature

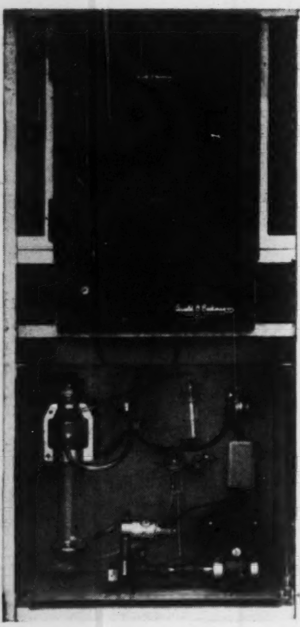
- ☐ Bulletin 4300 (Introduction to SR-4 Devices)
- ☐ Bulletin 4301 (SR-4 Load Cells and Load Beams)
- ☐ Bulletin 4302 (SR-4 weighing of tanks, bins, hoppers)
- ☐ Bulletin 4306 (SR-4 Fluid Pressure Cells)

Name __________ Title __________

Company __________

Address __________

City __________ Zone _____ State _____

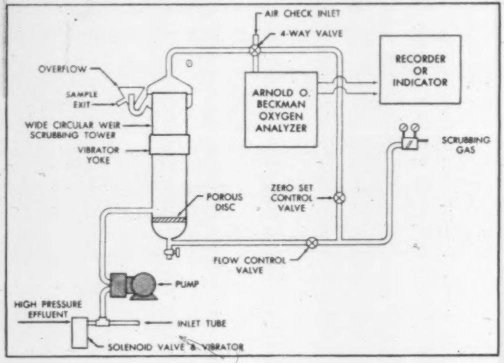


NEW
Arnold O. Beckman
DISSOLVED OXYGEN ANALYZER
for continuous measurement!

- ***handles fluids, sludges, etc.***
- ***simple operation***
- ***accurate and continuous measurement***

Photo shows analyzer in top section, scrubbing unit below.

Diagram illustrates how O_2 is stripped from sample with scrubbing gas, then resulting gases analyzed for O_2.



Accurate measurement of dissolved oxygen is recognized as an important control factor in operations such as sewage and water treatment, waste disposal, chemical processes, and many others.

Now you can accurately, simply, and continuously make such measurement—with the new Model 1A3B Dissolved Oxygen Analyzer!

The new Model 1A3B combines the field-proved Arnold O. Beckman paramagnetic Oxygen Analyzer with an improved method of stripping to provide a measurement specific for oxygen.

The Model 1A3B can be directly connected to any standard potentiometer-type recorder or indicator. No special accessory equipment is needed. Readings may be in percent saturation or ppm.

The Model 1A3B is adaptable to handling samples with high solids content . . . under abnormal temperatures or pressures . . . or those having other difficult sampling conditions.

Using the Model 1A3B is far superior in speed, accuracy, and convenience to conventional chemical methods. Information needed for optimum processing is provided immediately.

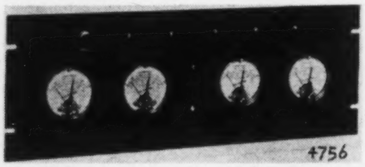
Ranges: *From a maximum of 0-100% O_2 saturation to a minimum of 0-5 ppm full scale. Intermediate ranges also available.*

Accuracy: *3% of full scale.*

Get the full story on the Model 1A3B. Write directly for information. Ask for Data File # 17G-65

Arnold O. Beckman INC.
Instruments for Science and Industry
1020 MISSION STREET
SOUTH PASADENA, CALIFORNIA

For more information circle **41** on inquiry card.



can be substituted. Each installation has a 50-amp. circuit breaker for shutdown; or, if alarm is preferred, a plug-in "Series 1818" relay with contacts rated 10 amps. at 100 v. non inductive.—*Assembly Products, Inc Chesterland, Ohio.*

For more information circle **223** on inquiry card.

Thermistor-varistor Kit

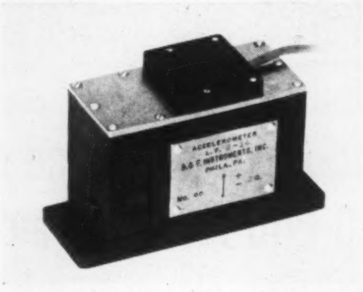
New "Deluxe Kit No. 168A" contains two each varistor washers, thermistor washers, discs and beads, and one each thermistor probe and rod, as well as miscellaneous mounting hardware.—*Victory Engineering Corp., Union, N. J.*

For more information circle **224** on inquiry card.

FORCE, VIBRATION, DISPLACEMENT, etc.

Acceleration Pickups

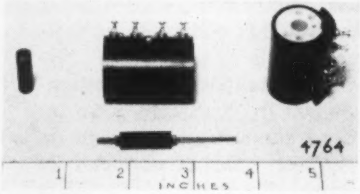
New "Model LF Accelerometers" are designed specifically for oscillographic recording of quasi-static and low-frequency (7 to 20 cps.) accelerations from plus and minus 2.5 *G* to plus and minus 10 *G* without higher frequency contamination. No amplifiers are required.—*B & F Instruments, Inc., 4732 N. Broad St., Philadelphia 41, Pa.*



For more information circle **225** on inquiry card.

Displacement Pickups

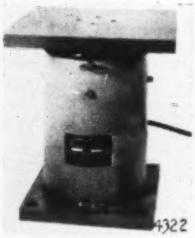
New models of "Microformers" are available with optional mounting attachments. (These miniature variable transformers were formerly produced only for use on maker's recorders and extensometers.) Standard size has a maximum core travel of 0.12 in., is 1½ in. long. A smaller size, 1 in. long, has a maximum core travel of 0.06 in. These are mounted by screw lugs or flat lugs.—*Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.*



For more information circle **226** on inquiry card.

Pulse sequence changed

Floor-level Scale

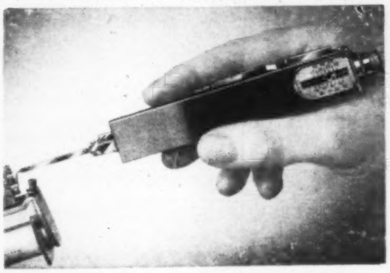


New 500-lb. capacity floor-level scale can be set in a pit 10½ in. square and less than 12 in. deep; incorporates a single "SR-4 Load Cell."—*Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.*

For more information circle **227** on inquiry card.

Tension Gages

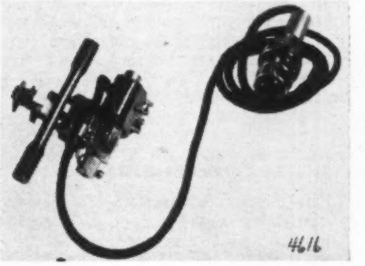
New tension gages can check spring tensions in range from 4 to 2500 grams. Knife-edge bearings provide negligible friction, and gravitational effects are accurately counterbalanced. Six models cover following ranges in grams: 4 to 24, 10 to 80, 50 to 250, 100 to 500, 200 to 1600, and 500 to 2500.—*Imtra Corp., 58 Charles St., Cambridge, Mass.*



For more information circle **228** on inquiry card.

Extensometer

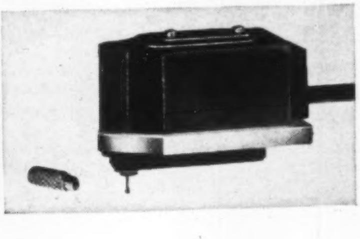
New "Model T-2M" non-averaging, snap-on "Microformer"-type extensometer features short gage lengths and interchangeable attachments for three different gage lengths: ½, ¾, and 1 inch. Specimens may be from ⅛ to ¼ in. diam.—*Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.*



For more information circle **229** on inquiry card.

Vibration Pickup

New "Type 115 Pickup" can be used to explore surfaces, bearings, lightweight objects; is attached to a



All Process Temperatures Now Recorded on One Chart at Low Cost

ROBERTSHAW-FULTON CONTROLS CO.
Fielden

FACTS ABOUT THE FIELDEN MULTI-POINT RECORDER

- Records on one chart as many as 6, 24, 48 or even 96 points of temperature, pressure, level, pH, conductivity, speed, etc.
- Can be provided with control function having a single point or individually controlled points.
- Provides easy readability with 6 different color traces in each segment of the chart.
- High-speed recording—5 seconds per point.

Many process plants are now finding that they can accurately record all process temperatures or other variables of the same kind on one Fielden MULTI-POINT Recorder at a new low in cost per point.

Results in numerous applications show that Fielden MULTI-POINT Recorder not only provides all the accuracy needed for most processes (±0.5%), but its high speed insures quick warning of any upsets. In addition, the instrument's simplified design enables plant personnel to handle any maintenance. These design features provide big savings in initial and operating costs.

Send the coupon today, and learn how *Fielden Simplified Instrumentation* can solve your problems too . . . dependably *and* economically.

Robertshaw-Fulton®
CONTROLS COMPANY

FIELDEN INSTRUMENT DIVISION
Dept. A, 2920 N. 4th St., Philadelphia 33, Pa.

Please send me bulletins describing:
☐ TEKTOLOG Recorder-Controller
☐ NULL-BALANCE Recorder-Controller
☐ FIELDEN MULTI-POINT Recorder-Controller
☐ TEKTOR Level Limit Control
☐ TELSTOR Continuous Level Indicator

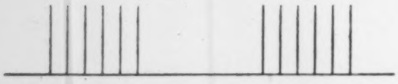
NAME ____________ TITLE ____________
COMPANY ____________
STREET ____________
CITY ____________ ZONE ______ STATE ______

For more information circle **42** on inquiry card.

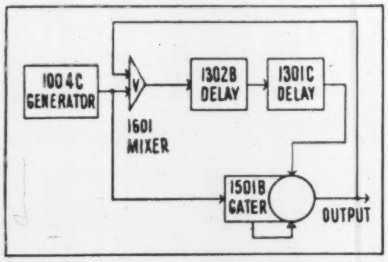
Dual-Grating Spectrograph

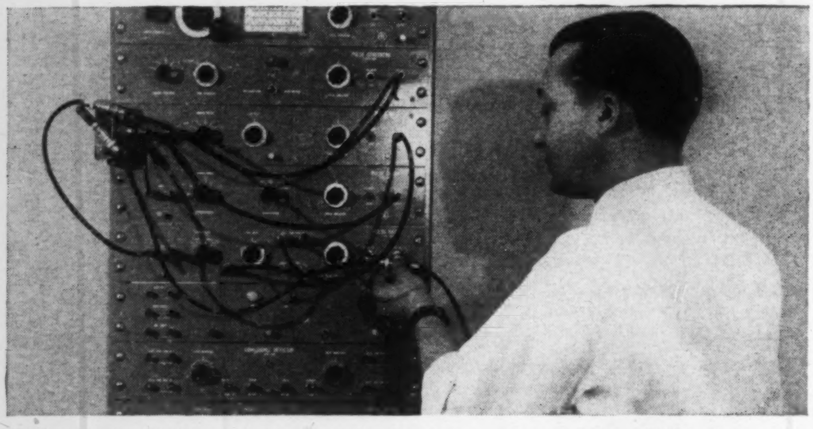
Pulse sequence changed in 10 minutes with

BURROUGHS PULSE UNITS

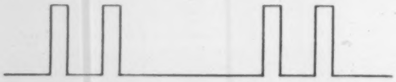


1. Multiple pulse group generator. Number of pulses in group can be changed by varying delay time in pulse gater. Group repetition rate is varied by adjusting frequency of pulse generator. Distance between pulses is continuously variable by means of a front panel control knob.

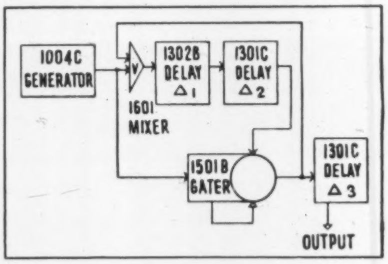




2. 10-minute changeover. Engineer simply connects one new delay unit into the system and sets up controls for new pulse sequence. Units are matched to each other; so no buffers are required. Units connect together through standard cables.



3. Pulse train generator. Presto! A completely new pulse system that generates trains of pulses of variable width. Panel controls give engineer easy adjustment of pulse number, pulse width, interval between pulses, spacing of pulse trains.



Burroughs CORPORATION
ELECTRONIC INSTRUMENTS DIVISION
1209 Vine St., Dept. 5-F, Phila. 7, Pa.

Send me detailed literature on Burroughs Pulse Units

Name____________________
Position____________________
Company____________________
____
Street____________________
City____________Zone______
State____________________

FREE ENGINEERING SERVICE

Let Burroughs engineer a system for you. Next time you have a problem involving pulses, write Burroughs, giving the pulse sequence desired. Get back complete information on how you can build the needed pulse system in just minutes with Burroughs Pulse Units. Prove to your management how much money and time you can save. Write or send coupon for literature.

For more information circle **43** on inquiry card.

pivoted coil moving between Alnico V permanent magnets; generates voltage corresponding to motion. Signal is generally fed to vibration meter, recorder, spectrum analyzer and other instruments.—*MB Mfg. Co., Inc., New Haven* 11, *Conn.*

For more information circle **230** on inquiry card.

LABORATORY

Non-destructive X-ray Scanning Spectrometer

New "X-ray Scanning Spectrometer," suitable for qualitative or semi-quantitative analysis, is said to provide accuracy comparable to best chemical methods, with procedural simplicity, and speeds similar to direct-reading optical emission. Standard samples last almost indefinitely. Instrument is designed for either analytical research or production control, —*Applied Research Laboratories, Glendale, Calif.*

For more information circle **231** on inquiry card.

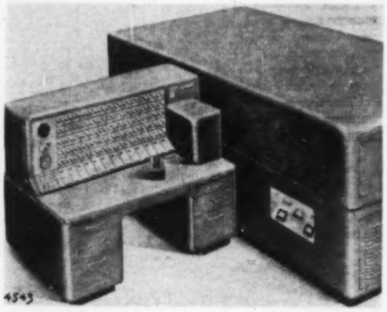
Spectrographic Standards

New set of eight low-alloy steel spectrographic standards, now made available in U. S. by Jarrell-Ash, were issued by British Bureau of Analyzed Samples, Ltd.; were prepared by Edgar Allen & Company, Ltd., Imperial Steel Works, Sheffield, England. Standardization was accomplished through cooperative analysis by twelve analytical chemists representing their respective steel firms. —*Jarrell-Ash Co.,* 26 *Farwell St., Newtonville* 60, *Mass.*

For more information circle **232** on inquiry card.

Spectrograph

New "Spectro Analyzer," said to be "laboratory world's first all-electronic spectrograph," analyzes up to 65 elements in two minutes, releasing some twelve chemists for more productive work than manipulation; is claimed to have six advantages over other direct-reading spectrographs.—*Fisher Scientific Co.,* 717 *Forbes St., Pittsburgh* 19, *Pa.*



For more information circle **233** on inquiry card.

Dual-Grating Spectrograph

New spectrograph achieves high degree of speed and versatility through use of two gratings, which provides two different spectral ranges in a single exposure on a single plate or on two different plates. One grating with a range of 2000A (1st order) operates in a practical range of 1850 to 24000A; second grating with range of 1000A (1st order) operates in range of 1850 to 12000A. Spectra are recorded on a flat 4 by 10 inch plate or on two 2 by 10 inch plates. Dispersions are available from 8A/mm to 1.33A/mm. Resolution is over 160,000 in the second order.—*Bausch & Lomb Optical Co., 635 St. Paul St., Rochester 2, N. Y.*

For more information circle **234** on inquiry card.

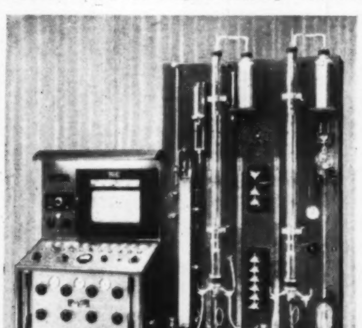
Infrared Recording Spectrophotometer

New "Model 4-55," designed for either quantitative or qualitative analysis, is a double-beam instrument equipped with a series of controls for utmost flexibility. Recording system can be readily converted to optimal conditions for quantitative or qualitative programs, with scanning speed, slit width and amplifier gain easily varied by individual controls. A unique "floating-balance" measuring system insures precision in quantitative work. Large size optical components make possible high resolution and precision at fast scanning speeds. One-minute interchange of prisms is one-tenth of time required with other instruments. Use of four prisms (NaCL, CaF, LiF and KBr) gives spectral range of 1.5 to 26 microns with maximum performance at all ranges. Instrument can be operated on a round-the-clock basis, and will produce up to 100 complete spectra in 24 hrs.—*Baird Associates, Inc., 33 University Rd, Cambridge 38, Mass.*

For more information circle **235** on inquiry card.

HC Gas Analyzer

New "Thermocon" automatic apparatus is for light hydrocarbon analysis by low-temperature distillation. Attainable accuracy has been improved, even for gas samples as small as 100 cc., through use of (1) high-sensitivity thermal conductivity cell of less than 2 cc. gas holdup (instead of usual thermocouple holdup of 20 to



an ACCO product

Helicoid Gages

Exclusive HELICOID
no-gear movement

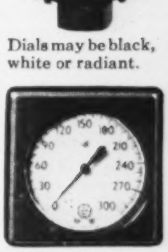
For day-in, day-out Sustained Accuracy
—for the life of the gage—
HELICOID Quality
costs you less!

- It's the basic design of HELICOID Gages that makes them outlast and out-perform ordinary gear-tooth gages. This enduring accuracy is evidenced by the smooth rotation of simple spiral roller and cam.

If you use gages it will pay you to investigate HELICOID performance records. There is a HELICOID long-life gage to meet every type of pressure indicating requirement. Ranges are to 20,000 p.s.i. and vacuum or compound.

Write today for Helicoid G-2 Catalog

Dials may be black, white or radiant.



Wall or stem mounting cases—flush panel or flangeless cases.

ACCO

Helicoid Gage Division
AMERICAN CHAIN & CABLE

TRADE MARK

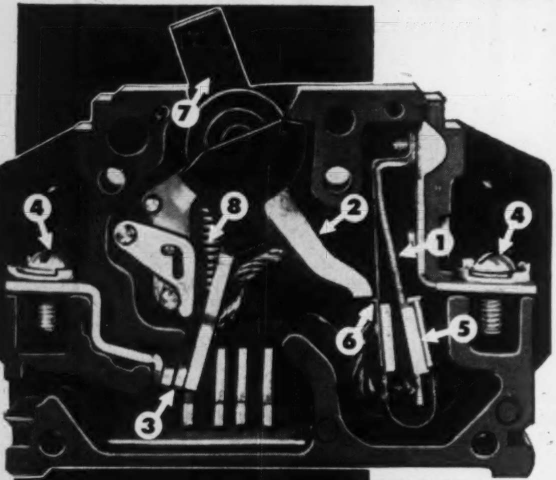
929-B Connecticut Avenue • Bridgeport 2, Connecticut

Pressure • Vacuum • Compound

For more information circle **44** on inquiry card.

HOW CHACE THERMOSTATIC BIMETAL ACTUATES THE I-T-E CIRCUIT BREAKER

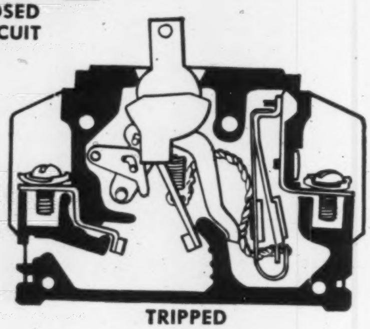
PRODUCT OF
I-T-E CIRCUIT BREAKER CO.,
PHILADELPHIA, PENNSYLVANIA



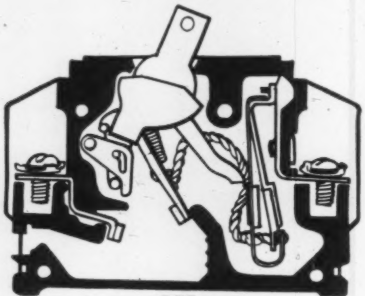
NOMENCLATURE

1 BIMETALLIC ELEMENT
2 LATCHING ARM
3 CONTACTS
4 TERMINAL
5 INSTANTANEOUS MAGNETIC TRIP
6 LATCH TRIP
7 MANUAL OPERATING HANDLE
8 SPRING

CLOSED CIRCUIT



TRIPPED



OFF

I-T-E type EQ breakers are designed for use in panelboards and load centers or for individual mounting where the voltage does not exceed 120 volts a-c to ground. It combines thermal-magnetic tripping action to afford complete protection against both small overloads and short circuit faults. Arc chutes, silver alloy contacts and a quick make-and-break trip-free mechanism combine to make this a premium grade breaker. It is furnished in either one or two pole designs.

HOW IT OPERATES

An element of Chace Thermostatic Bimetal furnishes the actuating medium for breaking the circuit under conditions of small, gradual overload. The bimetal strip (1) is carefully and accurately calibrated to deflect at a predetermined temperature range. Its deflection directly actuates the tripping mechanism of the circuit breaker by releasing the spring-loaded latching arm at (2) causing the contact rocker to break the circuit instantly at contacts (3) in response to the same spring tension. **Chace Thermostatic Bimetal is available in 29 different types, in strip, coils or in complete elements fabricated to customer specifications. Send for our new, free 36-page booklet, "Successful Applications of Chace Thermostatic Bimetal," containing valuable engineering information for designers of thermally responsive devices.**

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1609 BEARD AVE., DETROIT 9, MICH.

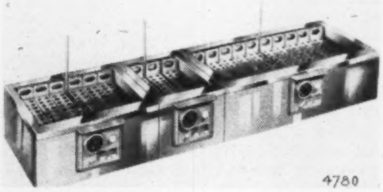
For more information circle 45 on inquiry card.

60 gas cc.), (2) dual boiling point and thermal conductivity recording of distillation curve; and (3) built-in "reanalysis" system for checking and enhancing accuracy as well as for speeding up analyses. Distillation times have been reduced by as much as 50 percent.—*Podbielniak, Inc., 341 E. Ohio St., Chicago 11, Ill.*

For more information circle **236** on inquiry card.

Water Baths

Two new serological water baths are 3-rack and 10-rack units; feature lifetime radiant wall heaters, "Forward-look" hood containing thermostat, pilot light and line switch.—*Chicago Surgical & Electrical Co., 217 N. Desplaines St., Chicago 6, Ill.*

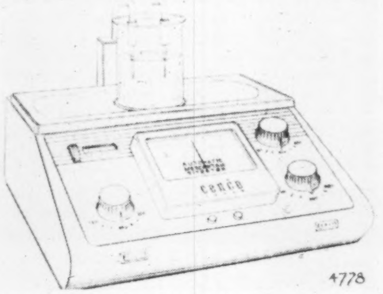


4780

For more information circle **237** on inquiry card.

Coulometric Titrator

New "Cenco Automatic Mercaptan Titrator," using coulometric system of operation, was developed by Standard Oil Co. (Indiana); is capable of measuring unusually low concentrations of mercaptan; provides petroleum industry with a simple and accurate method. Announcement states that previous titration methods were time-consuming and required a great deal of operator skill.—*Central Scientific Co., 1700 Irving Park Rd, Chicago, Ill.*



4778

For more information circle **238** on inquiry card.

Bottle Pump

New bottle pump removes distilled water and other liquids from carboys, tanks, etc. Air forced into container is automatically cleaned by "Ventgard" filter which removes and absorbs impurities before it can enter container to replace liquid being pumped out.—*Barnstead Still & Sterilizer Co., 2 Lanesville Terrace, Forest Hills, Boston 31, Mass.*

4617

For more information circle **239** on inquiry card.

Oxygen Analyzer

New portable "Model C2P" can be used for measuring continuously-flowing samples, or for fixed volume samples as small as 3 cc.; is available in practically any desired range of 5 percent or more between 0 and 75 percent oxygen and in ranges of 15 percent or more between 75 and 100 percent oxygen. Accuracy within 1 percent of full scale is made possible by paramagnetic principle: direct physical measurement of oxygen itself, not of some variable secondary function or relationship. Response: 95 percent of final reading within 40 seconds on standard models (within 7 seconds on special models).—*Arnold O. Beckman, Inc., 1020 Mission St., South Pasadena, Calif.*

4767A
REAR VIEW

For more information circle **240** on inquiry card.

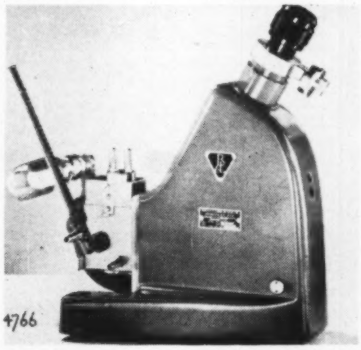
Corrosion Test Bomb

New "Copper Strip Corrosion Test Bomb" for ASTM D 130 is recommended for testing of gasolines, distillate fuel oils, cleaners' (Stoddard) solvent, etc. New design is said to eliminate many objectionable features of bomb formerly used.—*Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.*

For more information circle **241** on inquiry card.

Refractometer

New "Butyro Refractometer" increases speed and accuracy of purity tests on edible oils; permits direct readings through micrometer-equipped eyepiece in butyrol number accurate to 0.1 percent; is said to have "many features not available with previous instruments." Temperatures are kept constant with spiral flow copper heat exchangers around prism boxes. Both line and fixed scale are visible simultaneously in eyepiece. Samples are quickly changed; can be read by either transmitted or reflected light.—*Bausch & Lomb Optical Co., 635 St. Paul St., Rochester, N. Y.*



For more information circle **242** on inquiry card.

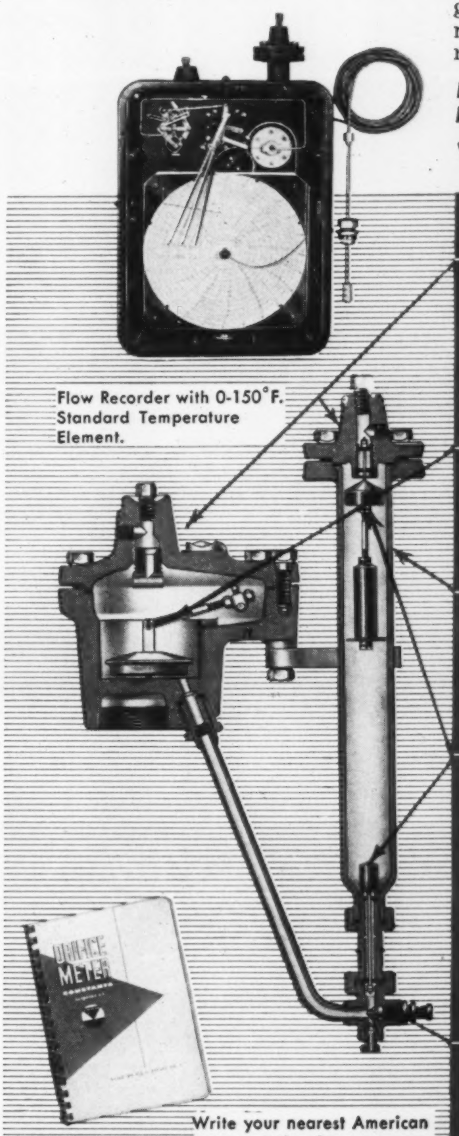
Meter Maintenance is SIMPLER... LESS COSTLY with American-Wescott Orifice Meters

Wherever precision measurement and economy of operation are required . . . at high or low flow rates . . . at varying temperatures . . . whether in recording, indicating, integrating or telemetering models, American-Westcott Series A-88 Orifice Meters are synonymous with accurate, dependable, trouble-free service and low maintenance costs.

American-Westcott Series A-88 standard mercury type orifice meters for working pressures to 5000 psi in interchangeable 10, 20, 50, 100 and 200-inch ranges give you complete versatility to meet any flow measurement requirements.

Recording • Indicating
Integrating • Telemetering

Write for full details.



Flow Recorder with 0-150°F. Standard Temperature Element.

CLEANING manometer body interior is easily accomplished through removal of high and low-side covers. Does not affect meter accuracy.

CALIBRATION is tamper-proof through simple, positive adjustment of float lever arm length.

EXTENDED HIGH SIDE chamber gives additional over-range protection — interchangeable without altering manifold piping.

MERCURY CHECK VALVES give positive shut-off for over-range protection.

TEFLON-PACKED STUFFING BOX is pressure tight, nearly frictionless, never requires lubrication, free from maintenance troubles.

TEFLON-PACKED PULSATION DAMPENER is externally adjustable under full line pressure.

Write your nearest American representative for your copy of the new Handbook E-2 based on AGA Report No. 3.

AMERICAN® METER COMPANY
INCORPORATED ESTABLISHED 1836

GENERAL SALES OFFICE: 1513 Race Street, Philadelphia • Albany • Alhambra • Atlanta Baltimore • Birmingham • Boston • Chicago Dallas • Denver • Erie • Houston • Kansas City Los Angeles • Minneapolis • New York • Omaha Pittsburgh • San Francisco • Seattle • Tulsa

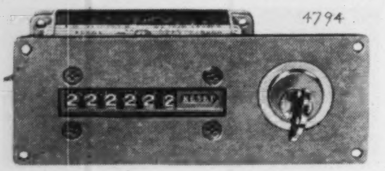
IN CANADA: Canadian Meter Company, Limited, Hamilton • Edmonton • Calgary

For more information circle **46** on inquiry card.

COUNTING, DATA-HANDLING, COMPUTING

Tamper-proof Counter

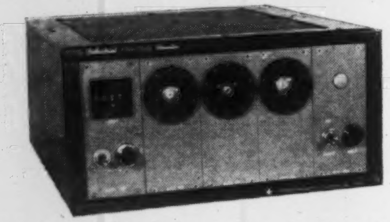
New tamper-proof tumbler-lock reset electric counter, "Model 6-Y-1-2-MF" is added to line of electrically-operated "Productimeters." Designed for panel mounting, it comes equipped with mounting plate, lock reset at right of plate. Assembly can be placed into a panel from front and securely fastened from front.—*Durant Mfg. Co.*, 1981 *N. Buffum Street, Milwaukee* 1, *Wis.*



For more information circle **243** on inquiry card.

240,000-cpm. Counter

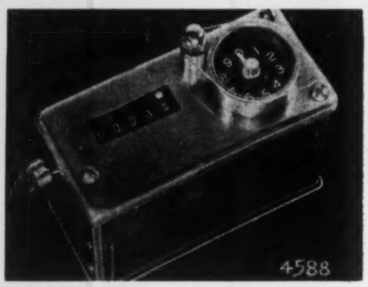
New "Model 8003 Fast Industrial Counter" achieves maximum counting rate of 4000 counts per second through a combination of low-heat cold-cathode glow transfer counting tubes and an electromechanical register. Pulse pair resolution is 250 usec. and total count capacity is 9,999,999. Counters are built from "Unitized Functional Plug-in Strips."—*Atomic Instrument Co.*, 84 *Massachusetts Ave., Cambridge* 39, *Mass.*



For more information circle **244** on inquiry card.

Pulse Counter

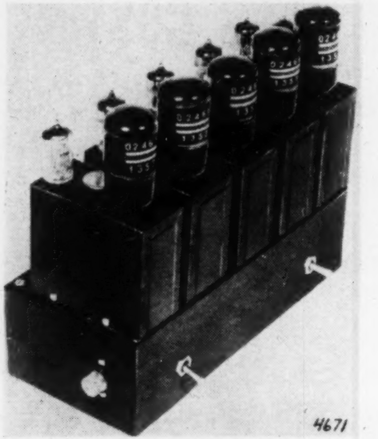
New "Cyclonome," said to offer advantages in speed and operational life over decade and mechanical registers, has rate of up to 130 counts per second. Either d-c. pulses down to 3 milliseconds wide or a-c. cycles with a minimum half-cycle of 3 milliseconds can be counted. Life of the Cyclonome is conservatively rated at 500 million counts. Photoelectric pickups can also be furnished. Stepping motor can be obtained as a separate component, with either 1.3 or 2.6 oz.-in. torque output; maximum stepping speed 260 half-steps per second.—*Sigma Instruments, Inc.*, 77 *Pearl St., S. Braintree, Boston* 85, *Mass.*



For more information circle **245** on inquiry card.

Electronic Counter

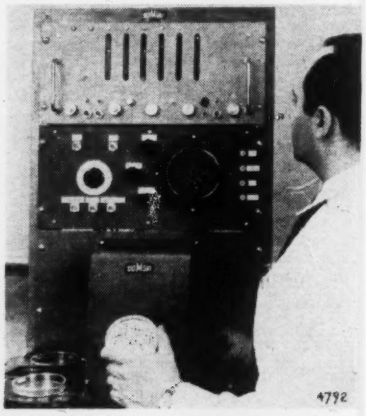
New "Model C-101" makes use of quickly interchangeable plug-in miniature decade counters; employs one 30-kc decade counter and four 10-kc decade counters.—*Ransom Research, P. O. Box* 382, *San Pedro, Calif.*



For more information circle **246** on inquiry card.

Ultrarapid Counter

New "Iconumerator" can count up to one million objects of varying shapes and sizes in one second. Illustration shows one unit for counting bacteria colonies in Petri dishes. Circuitry can be modified for wide variety of uses. Action may be likened to a human using his eyes, brain, and a pencil and paper. Instrument "sees" objects placed in a special compartment at front, counts the objects one-by-one, remembers what it has counted and transfers results to an electrical tote board, where they appear as lighted numbers. When desired, it can actuate an electrical printing machine. "Iconumerator" employs flying spot scanning principle. It will also count irregularly shaped objects. By changing optics, particles in air can be quickly spotted.—*Instrument Div., Allen B. Du Mont Labs., Clifton, N. J.*



For more information circle **247** on inquiry card.

Time and Frequency Counter

New "WE-210 Time Interval Meter and Frequency Standard" uses glow-transfer tubes in counter unit and a crystal-controlled oscillator as time base. Time is displayed directly to nearest 0.0001 sec. by four easily-read decades. Two ranges (1 and 10 sec.) are provided; longer intervals are easily noted by watching thousands decade, or through use of an electro-mechanical register. Maximum counting rate 50,000 pulses per second.—*Westport Electric*, 149 *Lomita St., El Segundo, Calif.*

For more information circle **248** on inquiry card.

Digitizer

New "Datrac" data translator converts voltage to digital output at the rate of 100,000 samples per second. Will continuously furnish a parallel digital code at its output from a varying voltage input every 10 microseconds; also provides immediate follow-up of each new signal input with a digital code at the output.—*Epsco, Inc.*, 588 *Commonwealth Ave., Boston* 15, *Mass.*

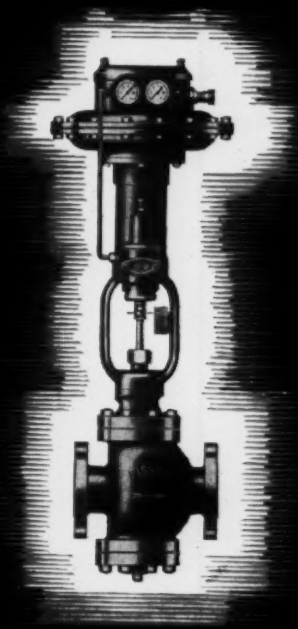
EPSCO
DATRAC
4636

For more information circle **249** on inquiry card.

Electronic Computer

New "G-15 General Purpose Digital Electronic Computer" is said to be "capable of solving the lengthy and complex problems of research and engineering organizations." It features an improved two-address command structure. Commands provide for addition, subtraction, multiplication and division as well as branching and other logical operations. Standard input and output devices include an electric

Circle **47** on inquiry card.→



FISHER **WIZARD** --- UNIVERSALLY ACCEPTED AS THE WORK HORSE ON SIMPLE PRESSURE CONTROL JOBS

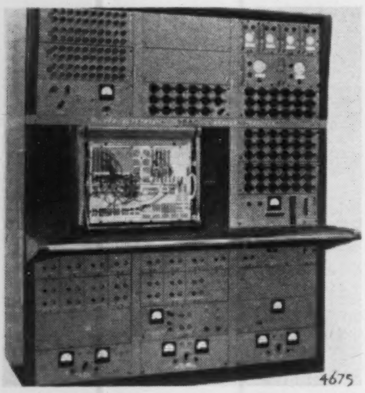
FISHER GOVERNOR COMPANY • Marshalltown, Iowa

WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL typewriter, a photoelectric tape reader and a mechanical tape punch. Accessory magnetic tape units are available for additional storage or input and output purposes.—*Bendix Computer, 5630 Arbor Vitae St., Los Angeles 45, Calif.*

For more information circle **250** on inquiry card.

Analog Computer

New "400 Series REAC" features unique method of verification of problem solutions and a new "building block" design; supersedes earlier "100" and "200" series REAC lines. Unique problem check presents, for first time in an analog computer, method of verification of problem before it is run.—*Reeves Instrument Corp., 215 E. 91 St., New York 28, N. Y.*



For more information circle **251** on inquiry card.

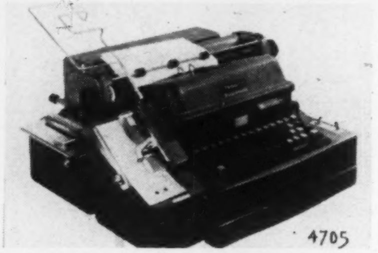
Digital Computer

New "ALWAC III," latest in maker's line of digital computers, was developed for small organizations with large computational requirements; utilizes magnetic drum storage with 4096-word memory capacity. Word length is 32 binary digits plus sign. Two instructions can be stored in space occupied by one word; 78 single address instructions are available. Final results are printed out with form control, signs, decimal points, and alphabetical headings under control of a sequence of instructions permanently stored on the magnetic drum. Components are pluggable subassemblies.—*Logistics Research, Inc., 141 So. Pacific Ave., Redondo Beach, Calif.*

For more information circle **252** on inquiry card.

Tape-controlled Typewriter

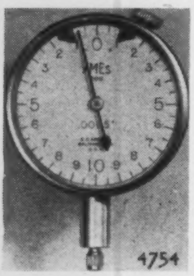
New "Programatic Flexowriter" reads edge-punched cards or punches paper tape and automatically prepares documents and by-product tape for data processing; provides for punching master record cards or tape used for document preparation. Tape and cards can be used interchangeably. Available in 5-channel or 8-channel tape models.—*Commercial Controls Corp., 1 Leighton Ave., Rochester 2, New York.*



For more information circle **253** on inquiry card.

MECHANICAL GAGING and TESTING

Tolerance Hands



Newly designed tolerance hands, for maker's micrometer dial gages and dial indicators, are located directly above dial, under crystal, which makes pointers easier to see, eliminates parallax and prevents hands being moved accidentally.—*B. C. Ames Co., Waltham 54, Mass.*

For more information circle **254** on inquiry card.

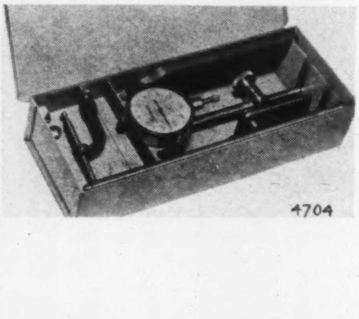
Height Gage

New model of "Chesterman" height gage uses a triangular scale beam for superior strength and exceptional rigidity, preventing sway and vibration. Sliding head moves through its entire range by action of full-length large-diameter screw in rear of beam. Available sizes 12, 18, 24, 40 and 48 in.—*George Scherr Co. Inc., 200 Lafayette St., New York 12, N. Y.*

For more information circle **255** on inquiry card.

Dial Indicator Test Set

New checking unit for machinists, tool makers, and inspection departments, consists of one Geneva Dial Indicator in either 0.001-in., 0.0005-in. or 0.0001-in. graduations, and variety of attachments for checking parts in almost any conceivable position, all in dust-free metal box.—*Chicago Dial Indicator Co., 180 N. Wacker Drive, Chicago, Ill.*



For more information circle **256** on inquiry card.

Measuring Magnifier

New "vest-pocket" comparator features glass reticle instead of film reticle found on other miniature comparators. Reticle pattern is etched in glass; glass will not bend or warp. Special feature of reticle is thickness comparison scale (parallel lines 0.002 to 0.007 inch apart) making possible direct measurement of thicknesses of sheet materials such as paper or plastic. Both reticle and object to be measured are magnified six times.—*Edmund Scientific Corp., Barrington 3, N. J.*

For more information circle **257** on inquiry card.

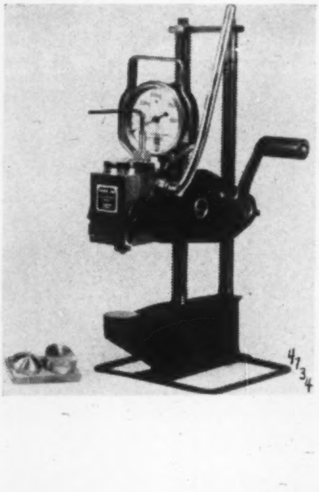
Universal Tester-recorder

New table model of maker's universal testing instrument records stress-strain curves under tension or compression. Full-scale load ranges from 2 grams to 200 lbs. available through choice of three load cells. Inertialess weighing permits rapid response to load fluctuations in sample. High-speed recorder is equipped with magnetic clutches and change gears provide choice of constant and reversible testing speeds over 250-to-1 range. choice of synchronous chart speeds. —*Instron Engineering Corp., 2 Hancock St., Quincy 71, Mass.*

For more information circle **258** on inquiry card.

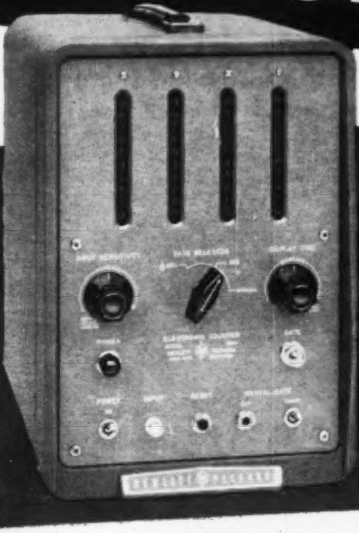
Hardness Tester

New portable, light-weight hardness tester, for Brinell tests on all kinds of non-ferrous alloys, has re-



New, low cost, versatile

INDUSTRIAL COUNTER



Measures frequency, speed, rpm, rps, random events

Measures weight, pressure, temperature, acceleration*

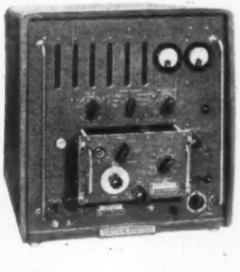
Direct numerical readings 1 cps to 120 KC

High accuracy, simple operation, compact, rugged

-hp- 521A—$475.00

New *-hp-* 521A is designed to be the most useful, accurate low cost industrial counter ever offered. It measures frequency, speed, rpm, rps, and counts random events within a selected time interval. With transducers, it measures weight, pressure, temperature, acceleration and other phenomena which can be converted to frequency. It is direct reading in cps, rpm or rps, and can be used readily by non-technical personnel. Period of count is 0.1 or 1 second; display time can be varied. The 50/60 cycle power circuit is used as the time base; or, for greater accuracy, a plug-in crystal controlled time base is available at extra cost. There are accessory power supplies of —150 v dc, + 300 v dc and 6.3 v ac. Connections are also supplied for photocells and an external 60 cycle standard. Lightweight, compact, sturdy; particularly useful with *-hp-* Optical Tachometer Pickups and Tachometer Generators. *-hp-* 521A, $475.00 (with plug-in crystal time base, $575.00).

Other versatile *-hp-* Counters

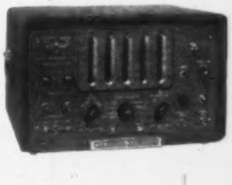


-hp- 524B Electronic Counter with 525/526 series Plug-Ins. Revolutionary all-purpose, direct-reading counter. Buy basic counter, plug-ins giving measuring coverage you need now. Later add other inexpensive plug-ins to double, triple counter's usefulness. Basic counter range: Frequency 10 cps to 10 MC, period 0 cps to 10 KC, stability 1/1,000,000. *-hp-* 524B, $2,150.00Δ.

-hp- 525A/B Frequency Converters extend 524B's range to 100 or 220 MC, increase video sensitivity. *-hp-* 525A/B, $250.00.

-hp- 526A Video Amplifier increases counter's sensitivity to 10 mv, 10 cps to 10 MC. $150.00.

-hp- 526B Time Interval Unit permits counter to measure interval 1 μsec to 100 days with accuracy of 0.1 μsec, ±0.001%. $175.00.



-hp- 522B Electronic Counter. Compact, moderate price; frequency, period or time measurements. 10 cps to 100 KC. Reads direct in cps, KC, seconds, milliseconds. Automatic count reset, repetitive action. Stability 5/1,000,000, display length variable. Easily used by non-technical personnel. $915.00Δ.

-hp- 508A Tachometer Generators. Use with electronic counters, frequency meters to measure directly 15 to 40,000 rpm. Produces 60 cycle output frequency per revolution; (*-hp-* 508B produces 100 cycles) *-hp-* 508A or 508B, $100.00.

-hp- 506A Optical Tachometer Pickup. For measuring rotation 300 to 300,000 rpm. Ideal for moving parts of small energy or where mechanical connection is impractical. $100.00.

*Data subject to change without notice. Prices f.o.b. factory. ΔRack mount slightly less. *With transducers.*

Electronic Test Instruments

Quality, value, complete coverage

HEWLETT-PACKARD COMPANY

3342C Page Mill Road • Palo Alto, Calif. • Cable "HEWPACK"

PLEASE SEND INFORMATION ON:

___ 521A ___ 522B ___ 524B & Plug-Ins ___ 506A ___ 508A/B

Name ___

Company ___

Street ___

City ___ Zone ___ State ___

For more information circle **48** on inquiry card.

SOLVED

weighing
and
testing
problems
by

EMERY **force-measuring systems**

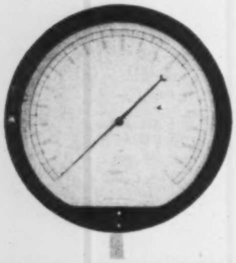
Emery load cells offer the fundamental solution to *any* force-measuring or weighing problem.

Operating on simple, basic physical principles, Emery systems are maintenance-free. Some units have been in service over 25 years without even recalibration!

RANGES: 0 - 10,000,000 pounds . . . **ACCURACY:** 1/10 of 1% of range . . . **RESPONSE:** less than ½ second . . . **TYPES:** self-contained hydraulic, open-flow hydraulic, pneumatic . . . **CELL DEFLECTION:** less than 0.005″ . . . **APPLICATIONS:** Weighing, Jet Engine Thrust, Brake Testing, Torque Measurements, Strength of Materials, Process Control, Tank Weighing, Platform Scales, Etc.

Since 1872, Emery Force-Measurement Systems have been lowest in initial cost, in operating cost, and require no maintenance.

Write today for information on stock or specially designed systems to solve your force-measuring problems.



THE A. H. EMERY COMPANY, NEW CANAAN 3, CONN.

Please send me
☐ Literature on hydraulic weighing
☐ Literature on pneumatic weighing
NAME ____________________
POSITION ____________________
Attach to, or write on, your company letterhead.

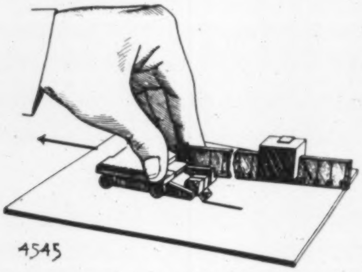
For more information circle **49** on inquiry card.

movable test head which makes it possible to test parts of any size or shape and in any position—even upside down, with or without base. Uses maximum applied load of 1000 kg.—*Andrew King, 67 E. Lancaster Ave., Ardmore, Penna.*

For more information circle **259** on inquiry card.

Scratch-hardness Tester

New "Hoffman Scratch-hardness Tester" determines also the adhesion of industrial product finishes. It is said to make an ideal combination with "Clarkstan Industrial Microscope" and both instruments can be carried in pocket.—*Gardner Lab., Inc., Bethesda* 14, *Md.*

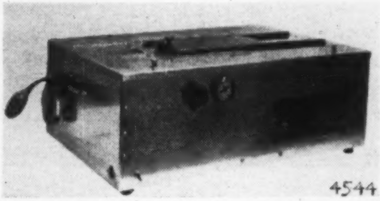


4545

For more information circle **260** on inquiry card.

Blush-resistance Tester

New "Gardner-Sharples Blush Cabinet" determines blush resistance of lacquers within 1 percent in minutes. Readings of temperature and humidity are made directly. Operation technique is simple.—*Gardner Lab., Inc., Bethesda* 14, *Md.*

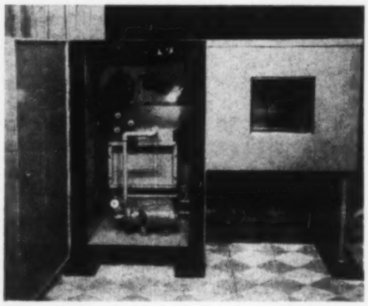


4544

For more information circle **261** on inquiry card.

Temperature-humidity Test Cabinet

New air-conditioned test cabinet provides full control of relative humidity (5 to 95 percent) and temperature. Method used is that of saturating air at required dew-point temperature and reheating to desired dry-bulb temperature.—*Niagara Blower Co.,* 405 *Lexington Ave., New York* 17, *N. Y.*



For more information circle **262** on inquiry card.

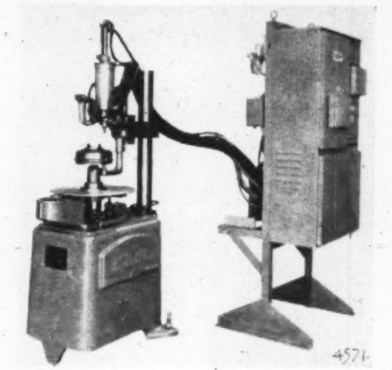
Temperature Test Chamber

New "Model TDI-8" 8-cu.-ft. high and low temperature environmental testing chamber features a removable dry ice compartment as a source of cold air; plugs into 110-v. line; is equipped with swivel casters for mobility. Temperature control is automatic; indicating or recording instrumentation optionally available.—*Tenney Engineering, Inc.*, 1090 *Springfield Rd., Union, N. J.*

For more information circle **263** on inquiry card.

Balancing Machine

"Model 6780" static balancing machine, with spot welder for correction of brake drums, has angular location of unbalance retained on universal level indicator; amount is calibrated in terms of slug class needed to correct it. When desired, balance can be checked with slug in place on workpiece before welding.—*Micro-Poise Engineering and Sales Co.*, 14851 *Grand River Ave., Detroit* 27, *Mich.*



For more informaton circle **264** on inquiry card.

Jet Engine Analyzer

New "Model J Jetcal Analyzer" tests exhaust gas temperatures (EGT) and engine speed (RPM) systems and isolates errors if they exist. Test of EGT thermocouple circuit is unique: uses specially-designed probes, each containing a "furnace" developing a precisely controlled temperature up to 900 C. and a test TC. In addition, analyzer checks individual TCs "on bench" before placement in harness and within harness, checks TCs and paralleling harness for accuracy, checks resistance and insulation of EGT circuit, checks EGT indicators in or out of aircraft, enables tabbing or micing of engine at optimal exhaust gas temperature and engine speed and functionally checks aircraft thermal switches.—*B & H Instrument Co., Inc., Fort Worth* 7, *Texas.*

Drawer for hot probes
4762

For more information circle **265** on inquiry card.

Mass spectrometry
on a practical industrial basis

Two companion instruments, Types 21-610 and 21-620, now extend the speed and accuracy of mass spectrometric analysis from the laboratory out into the plant. Flexible and simplified, needing only 115 volts and a small supply of cooling water, the twin instruments are easily adaptable to process-stream monitoring, batch work, or leak detection.

For monitoring & controlling streams to mass 80 . . .

TYPE 21-610 is moderately priced and a truly general-purpose instrument. Although primarily designed for continuous petroleum and petrochemical stream analysis, it is also valuable as a production-line leak detector or laboratory analytical instrument. It has been used in applications ranging from on-the-spot acetylene-plant monitoring to hospital clinical tests on lungs.

For higher resolving power, readings to mass 150 . . .

TYPE 21-620 has the highest mass range of any instrument in its compact size range. Using the newly developed "Cycloidal Focusing" principle for analysis, it goes beyond the 21-610 for accurate readings from mass 2 to mass 150. Medical laboratories, petro-chemical plants and general research organizations will all find it an ideal answer to their analytical problems.

Modifications . . . accessories

The 21-610 may be converted to a 21-620 whenever the latter's greater resolving power is needed. The work is accomplished by a CEC Field Service Engineer without return of the instrument to the factory. Involving primarily the exchange of some components and the addition of certain others, the conversion is made reasonably and quickly.

An extensive accessory line greatly broadens the utility of both the 21-610 and 21-620. Automatic peak selectors scan as many as six mass numbers on a repetitive cycle; sampling probes and magnet shunts make either instrument a practical production-line leak detector; batch-sample inlet systems and continuous-chart recorders (left) may be mounted directly on the instruments.

How industrial mass spectrometry can be used in *your* business is explained in Bulletin CEC 1824A-X20. Send for your copy.

Consolidated Engineering
Corporation
ELECTRONIC INSTRUMENTS FOR MEASUREMENT AND CONTROL

300 North Sierra Madre Villa, Pasadena 15, California

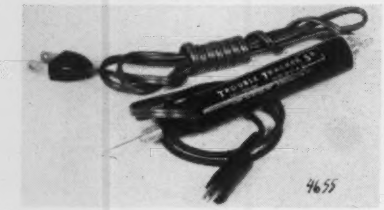
Sales and Service Offices Located in: *Albuquerque, Atlanta, Buffalo, Chicago, Dallas, Detroit, New York, Pasadena, Philadelphia, Seattle, Washington, D. C.*

For more information circle **50** on inquiry card.

ELECTRICAL TESTING

Circuit Checkers

New "Trouble Trackers" are circuit checkers for electricians, repairmen, and industrial engineers. "Trouble Tracker, Sr." can be used from 60 to

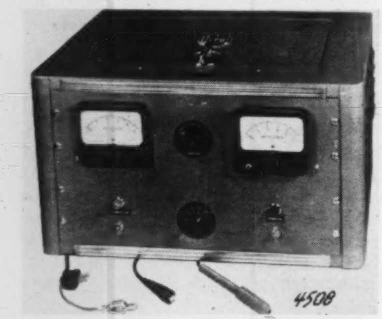


400 v.ac. or 90 to 400 v.dc., or on resistances up to 80 megohms. "Trouble Tracker, Jr." is for locating broken wires, bad connections, and short circuits.—*Link Aviation, Inc., Binghamton, N. Y.*

For more information circle **266** on inquiry card.

Insulation Tester

New "Model 424 d.c. Hypot" is instrument for dielectric testing up to 5000 v.d.c., and insulation resistance

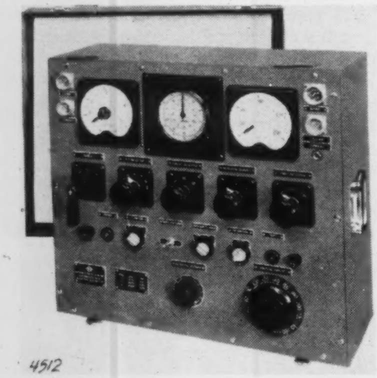


measurement up to 50,000 megohms. Featured is continuously variable output voltage of 0-5000 v.d.c.—*Associated Research, Inc., 3767 W. Belmont Ave., Chicago 18, Ill.*

For more information circle **267** on inquiry card.

Portable Relay Analyzer

New "Model 245 Portable Relay Analyzer" is equipped with facilities to accurately test and calibrate the in-

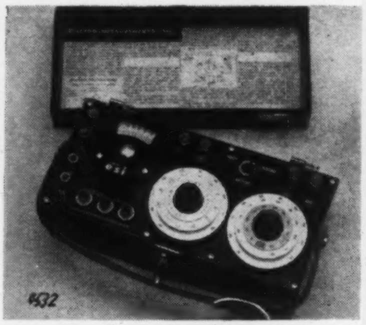


dividual elements of power system relays, circuit breakers, and other types of electrical equipment. Provides 0-270 volts and 0-125 amperes.—*Arthur E. Booth Co., 265 S. Alexandria Ave., Los Angeles 4, Calif.*

For more information circle **268** on inquiry card.

Fault Locating Bridge

New "Wheatstone and Fault Locating" bridge is designed for field operation. As Wheatstone Bridge, resistances from zero to 1.2 megohm



can be measured directly. For fault locating, Varley Loop ratios are 1/1, 1/4 and 1/9; Murray Loop ratios include 10, 100, and 1000. Instrument can be used also as continuity checker, capacitance checker, or precision four-dial decade box.—*Electro-Measurements, Inc., 4312 S. E. Stark St., Portland 15, Oregon.*

For more information circle **269** on inquiry card.

Signal Generator

New "Model 324" signal generator can be used for IF-RF alignment; signal tracing, and troubleshooting. Frequency range is 150 kc to 145 Mc

SIGNAL GENERATOR
MODEL 324

on fundamentals in 6 bands; and 111 Mc to 435 Mc on calibrated harmonics. —*Electronic Instrument Co., Inc., 84 Withers St., Brooklyn 11, N. Y.*

For more information circle **270** on inquiry card.

Variable-frequency Generator

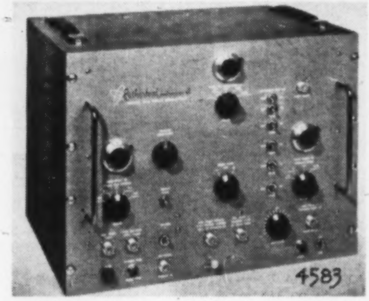
New "Model 1455" variable-frequency generator features: range of 20 cps to 18 kc in 6 ranges, full-load-no-load regulation of 2 percent, distortion less than 3 percent from 30 cps to 18 kc, and low dynamic output impedance of 70 ohms. Power output is 50 va into unity power factor.—*Communication Measurements Lab., Inc., 350 Leland Ave., Plainfield, N. J.*

VARIABLE FREQUENCY
ELECTRONIC GENERATOR

For more information circle **271** on inquiry card.

Pulse Generator

New "Model B-2A" has an added input trigger circuit to permit selection of external triggering levels and

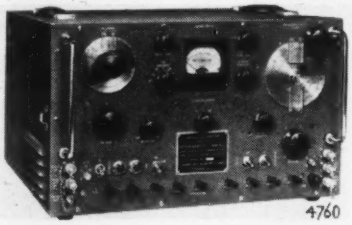


operation from slowly-rising trigger wave forms. Cooling fan has been relocated on rear of cabinet, quintupling area of dust filter and thus improving cooling. Output circuit has been changed to eliminate starting and switching transients.—*Rutherford Electronics Co., 3707 S. Robertson Blvd., Culver City, Calif.*

For more information circle **272** on inquiry card.

Signal Generator

New "Model 131," for testing circuits operating in 7-70-Mc. range, is capable of cw, pulse or sweep operation; features: built-in 5,000-Mc.



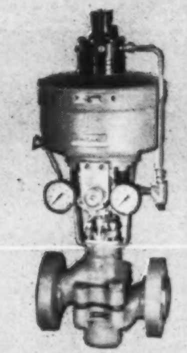
crystal frequency standard, electronic linear frequency sweep, continuously-tunable frequency marker, choice of two types of markers (spike or blanking), zero amplitude reference for sweep output, calibrated 0.5-v. rms. output to 50-ohm impedance, zero to 101-db step attenuator, and independent use of attenuator.—*Avion Instrument Corp., 299 State Highway No. 17, Paramus, N. J.*

For more information circle **273** on inquiry card.

Audio-sweep Generators

New "Model AB" (20-200,000 cps.), "AC" (2-20,000 cps.) and "ADB" (0.2-2000) cps. eliminate time-consum-

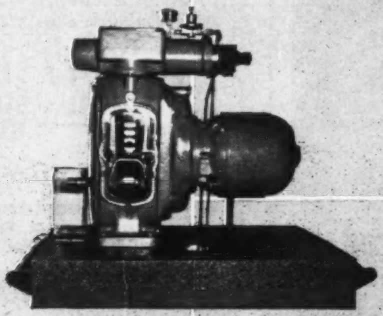
CONOFLOW *Cylinder Conomotors* now make possible a *complete selection* of FINAL CONTROL ELEMENTS



Conoflow Series LB Control Valve

CONVENTIONAL—Control Valve

One of the most conventional methods of controlling practically any variable is to use a control valve to regulate the fluid stream on the discharge side of a pump or similar prime mover. This is, of course, a simple and obvious approach, but frequently poses serious problems especially when handling extremely viscous materials, abrasive materials, corrosive fluids, etc. One of the proved and accepted methods of hurdling these perplexing obstacles is to control at the source by positioning . . . . .



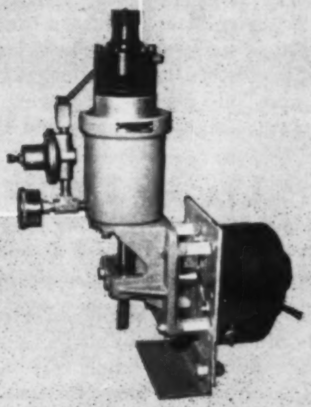
Cylinder Conomotor actuating variable speed drive (Link Belt)

. . . . . THE PRIME MOVER—*mechanically*

In this manner the prime mover is actuated directly by the control instrument—eliminating the necessity of breaking into the line downstream to install a control valve. A most common method of accomplishing this is to control the pump speed by means of a mechanical variable speed transmission. Cylinder Conomotors are available as original equipment on a wide variety of drive units similar to the one illustrated here, including U. S. Electrical Motors, Sterling Electric Motors, Graham Transmissions, Reeves Pulley, etc. Many pumps have been adapted for direct control by using Cylinder Conomotors to automatically adjust pump stroke as in the Lapp Pulsafeeder and Milton Roy pumps. In some cases it is more practical to control at the source through electrical means by modulating . . . . .

. . . . . THE PRIME MOVER—*electrically*

Conoflow EB Current Controllers operating from a 3-15 or other standard range pneumatic controller are available in over 200 combinations of electrical components for controlling voltage, current, inductance, capacitance, resistance or other electrical values. A common approach to the regulation of fluid flow in this manner is to position the rheostat in the motor field or the armature circuit as a direct function of signal pressure, thereby regulating the speed of the D.C. shunt-wound motor driving the pump. On many applications, variable speed transmissions and electric motors can be controlled from zero to full capacity offering a resultant control range that cannot be matched by conventional control valves. In installations involving large capacity equipment this can prove extremely important since it eliminates the needless operation of large centrifugal pumps running at constant speed wasting power by discharging against a stalled or greatly restricted head.



Conoflow EB Current Controller positioning rheostat

For additional information on Conoflow Cylinder Operators write for Bulletin B-50-2.

CC 900

ConoControls®

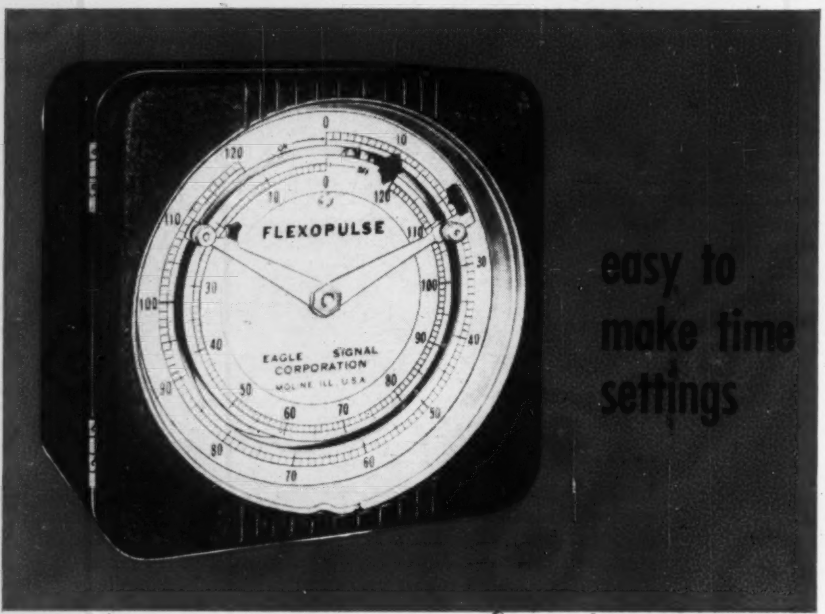
CONOFLOW CORPORATION

FOREMOST MANUFACTURERS OF FINAL CONTROL ELEMENTS

2100 ARCH STREET, PHILADELPHIA 3, PA.

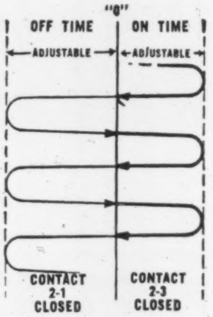
For more information circle **51** on inquiry card.

EAGLE FLEXOPULSE
repeat cycle timer
WITH S.P.D.T. SWITCH



No gear change or resetting of cams required

This Flexopulse Repeat Cycle Timer is ideal for controlling processing machines requiring adjustable timed cycles. The "on" or "off" intervals are easily adjusted. Either can be adjusted without disturbing the setting of the other. Instead of resetting cams or changing gears, simply loosen two knurled nuts. Then set "on" and "off" periods by moving two adjustable arms. Tighten screws, and the job's done.



HAS CYCLE PROGRESS INDICATION:

A movable flag indicator passing over the time scale between adjustable arms, indicates portion of cycle elapsed in either of the s.p.d.t. positions. Switching operation takes place at zero.

Flexopulse is ideal for periodically operating valves to reverse the flow of liquids, for operating signals or for injecting chemicals. 120-second up to 20-hour dials are available. Synchronous motor powered. Send coupon today for free Bulletin 320.

EAGLE TIMERS SAVE TIME . . . SAVE MONEY
EAGLE
SIGNAL CORPORATION
Industrial Timers Division
MOLINE, ILLINOIS

FREE BULLETIN, MAIL COUPON

EAGLE SIGNAL CORPORATION
Industrial Timers Division, Dept. IA-6
MOLINE, ILLINOIS

Please send free Bulletin 320 with full data on Flexopulse Repeat Cycle Timer.

NAME AND TITLE
COMPANY
ADDRESS
CITY ZONE STATE

For more information circle **52** on inquiry card.

ing job of point-by-point plotting of frequency response curves; display curves on a cathode-ray tube; is the first commercial instrument of its type and is said to be "the most versatile precision low-frequency measuring instrument on the market today."—*Technomatic Instrument Co., 11368 W. Olympic Blvd., Los Angeles 64, Calif.*

For more information circle **274** on inquiry card.

Corona Test Set

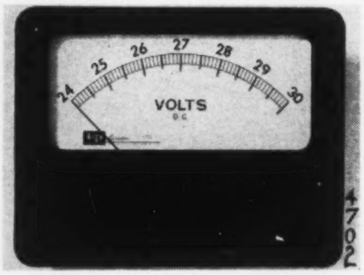
Nine new corona test sets utilizing 60-cps. a.c. range from 10 kv. to 30 kv. and 40 kva. for truly non-destructive h-v. testing; meet ASTM, MIL and JAN specs; feature straight-line 'scope presentation; can be safely operated by unskilled personnel; include all necessary controls and circuit refinements. Method: gradual application of a.c. to required test voltage or until corona starts, in which case starting-point is detected by unmistakable corona pulses on 'scope screen. —*Peschel Electronics, Inc., 13 Garden St., New Rochelle, N. Y.*

For more information circle **275** on inquiry card.

ELECTRICAL INSTRUMENTS

D-c. Voltmeters

New d.c. expanded-scale voltmeters for panel mounting feature linear scale which includes only useful span.

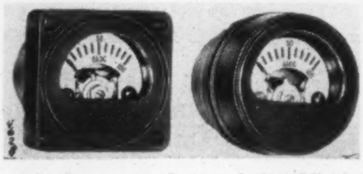


Standard base voltages 6.25 to 230, with span from 4 to 25 percent of base voltage. Hermetically-sealed and ruggedized models meet military specs. —*Arga Div., Beckman Instruments, Inc., South Pasadena, Calif.*

For more information circle **276** on inquiry card.

Sealed Panel Instruments

New 1-in. "Model 100" uses a miniaturized version of external-pivot d'Arsonval movement. Scale windows and

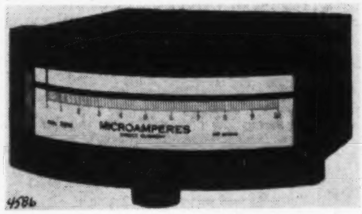


terminals are gasket-sealed. "O" ring panel gasket and locknut provide shock-proof mounting.—*Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.*

For more information circle **277** on inquiry card.

Panel Instruments

New line of precision reference-standard panel instruments are available in both edgewise and vertically mounted panel types. Curved-face edgewise types feature accuracy to 0.25 percent, flat-faced vertical type feature accuracy to 0.5 percent (in Model UPP). Various ranges are available in permanent magnet types, dynamometer types, moving iron types, or electrostatic types.—*Sensitive Research Instrument Corp.*, 9-11 *Elm Ave., Mount Vernon, N. Y.*


4586

For more information circle **278** on inquiry card.

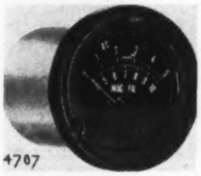
Panel-mounted VTVM

4598

New "Model F" is a complete dc. vacuum-tube voltmeter that can be mounted in operating or test equipment without exceeding area required by a standard panel instrument. Complete amplifier and power supply circuits are contained within housing, and terminals are available for dc. signal input and for 60-cps. power input. Available in single scale sensitivities from 1 to 300 volts. Multiple-scale operation readily tailored—either at factory or by equipment designer.—*Trio Labs., Inc.*, 3293 *Seaford Ave., Wantagh, L. I., N. Y.*

For more information circle **279** on inquiry card.

Multi-scale Instruments


4707

New "Series HD-647" indicators are available with up to five a-c. or d-c. scales in all sensitivities. Either 2½ in. (JAN-1-6) or 3½ in. (ASA) sealed housings combining drawn-metal cases and die-cast aluminum mounting flanges.—*De Jur Amsco Corp.*, 45-01 *Northern Blvd, Long Island City* 1, *N. Y.*

For more information circle **280** on inquiry card.

Microvoltmeter

4563

New "Model 202" microvoltmeter-amplifier is said to be "noteworthy for high input impedance, high sensitivity, high stability, instant polarity indication, and stable zero." Selector switch for 13 ranges from a base of 0-300 uv. to a peak of 0-300 v. Output terminals on rear permit new instrument to be used as a low-

I'm DALOHM...
miniature
but mighty!
You can
depend on
DALOHM
Ω
HERMETIC-SEAL
RUGGEDIZED

DEPOSITED CARBON RESISTORS

Produced under the most exacting methods of quality control. Ideal for use in UHF equipment where only the optimum of quality may be tolerated.

Completely high temperature alloy solder sealed in newly developed envelope of non-hydroscopic ceramic. Ruggedized for incorporation into "snap-in" clips. Production tested for resistance to thermal shock, salt-water immersion and humidity.

Three wattage ranges: DCSH-½, ½ watt; DCH-1, 1 watt; DCH-2, 2 watts.

- Resistance ranges to 200 megohms
- Temperature coefficient 140 PPM to 500 PPM per degree C
- Standard tolerance 1%

Meet MIL-R-10509-A Specifications

WRITE FOR BULLETIN No. R-27

DALE PRODUCTS, Inc.

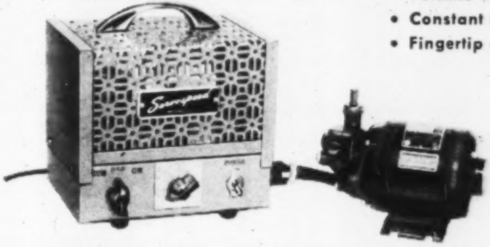
1310 28th AVE., PHONE 2139 COLUMBUS, NEBRASKA, U.S.A.

Export Dept.:
Pan-Mar Corp.,
1270 Broadway,
New York 1, N.Y.

For more information circle **53** on inquiry card.

VARIABLE SPEED CONTROL LABORATORY MODELS

- Assures proper process speed
- Permits 40:1 speed range while in motion
- Constant torque capability
- Fingertip control from remote point
- Electronic "Servo" control
- Wide range of available gearmotors
- 115 volt 50-60 cycle operation
- Reversible direction of rotation
- "Dynamic" fast stop "braking"



Uses: Laboratory agitators, running torque testers, life test fixtures, recording chart drivers, timers, etc.

MODEL 2792
with 1/50 h.p. motor
100-5000 r.p.m.
$89.50

MODEL 2792-G
with 1-40 r.p.m.
3 in./lb. gearmotor
$95.00

Also available with other motors • O.E.M. models for mounting into your enclosures

Servospeed DIV. of ELECTRO DEVICES, Inc.
4 Godwin Ave. Paterson, N. J.

For more information circle **54** on inquiry card.

WATCH YOURSELF!
(Everyone else does)

USE DIAMOND UtiliVue
INDUSTRIAL TELEVISION SYSTEM

Everyone can see those tall chimneys that carry off gases or fumes from your plant. Many of these people will judge unfairly . . . will blame you for everything from smog to tattle-tale grey wash . . . even though there is smoke for only a few minutes a day.

The "UtiliVue" (wired television) will bring a sharp picture of the stacks to the control panel or any other convenient point. The operator SEES the smoke exactly as do people on the outside and takes corrective action at once. Chimney smoke is only one of many things that the "UtiliVue" can watch to your profit and advantage . . . in fact, anything that is too remote, too hot, or too dangerous to observe directly. Get in touch with your Graybar Distributor or use the coupon below for informative booklet.

UtiliVue Camera

Monitor

7119

Distributed by GraybaR Electric Company

DIAMOND POWER SPECIALTY CORP.
FIRST IN INDUSTRIAL TELEVISION
LANCASTER, OHIO
OFFICES IN 39 PRINCIPAL CITIES
Diamond Specialty Limited—Windsor, Ontario
Since 1903, Diamond has Manufactured Quality Equipment for Industry

DIAMOND POWER SPECIALTY CORP.
ELECTRONICS DEPT., P.O. BOX 415S
LANCASTER, OHIO

Please send me without obligation a copy of new bulletin showing how Diamond Industrial (Wired) Television will help me reduce costs, improve quality, increase sales and aid safety.

Name__________

Title__________

Company__________

Address__________

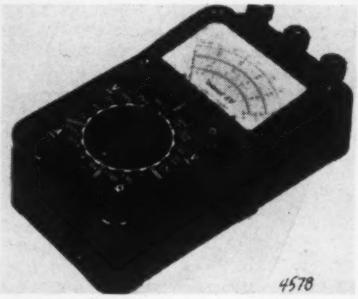
For more information circle **55** on inquiry card.

drift d-c. amplifier. Input circuit filter effectively eliminates 60-cps. components from d-c. voltage under measurement. Greatest possible stability is achieved by negative feedback encompassing rectifier, filter and all amplifiers.—*Kay Lab,* 1090 *Morena Blvd., San Diego, Calif.*

For more information circle **281** on inquiry card.

Electrical Indicating Instruments

New to U. S. is complete line of C. P. Goerz (Vienna). "Universal HV" (illustrated) measures voltage, current, resistance, and capacitance.



4578

High-voltage probe permits measuring direct voltages to 15,000. Decibel scale for attenuation.—*Physics Research Labs., Inc.,* 507 *Hempstead Turnpike, W. Hempstead, N. Y.*

For more information circle **282** on inquiry card.

Bridge Indicator

New "Model 101" resistance bridge indicator is a self-balancing instrument for measuring output of resistance-bridge acceleration, strain, pressure and position pickups, also resistance thermometers, with 1, 2 or 4 active legs.—*American Helicopter Div., Fairchild Engine & Airplane Corp.,* 1800 *Rosecrans Ave., Manhattan Beach, Calif.*

4701

For more information circle **283** on inquiry card.

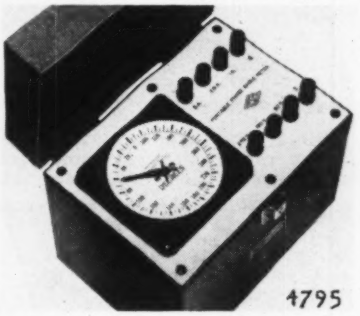
"L"-band Wavemeter

New "Model 228" is a coaxial line instrument covering frequency range 900-2400 Mc. by transmission. Among

features: HF stability through temperature range 10 to 40 C., extreme mechanical stability, 0.02 percent accuracy.—*Amerac, Inc., 116 Topsfield Road, Wenham, Mass.*
For more information circle **284** on inquiry card.

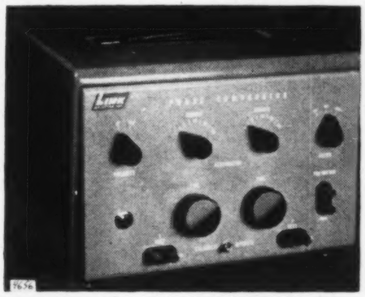
Phase-angle Meter

New "No. 648" is particularly useful in checking performance of directional overcurrent relays, etc.; also in measuring power factor in each phase of a polyphase watthour meter installation. Ranges 60, 120 and 240 volts; 1, 2.5 and 5 amps.—*The Eastern Specialty Co., Philadelphia 40, Pa.*
For more information circle **285** on inquiry card.


4795

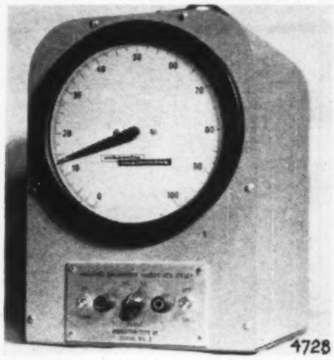
Phase Comparator

New "Model 201" phase comparator permits precision measurement of phase relationship of in-phase and out-of-phase voltages. Measures input voltages from 1.0 to 120 volts through a frequency range of 60 cycles to 400 cycles with an accuracy of 0.33 milliradian at 400 cycles, and 0.1 milliradian at 60 cycles.—*Link Aviation, Inc., Binghamton, N. Y.*
For more information circle **286** on inquiry card.



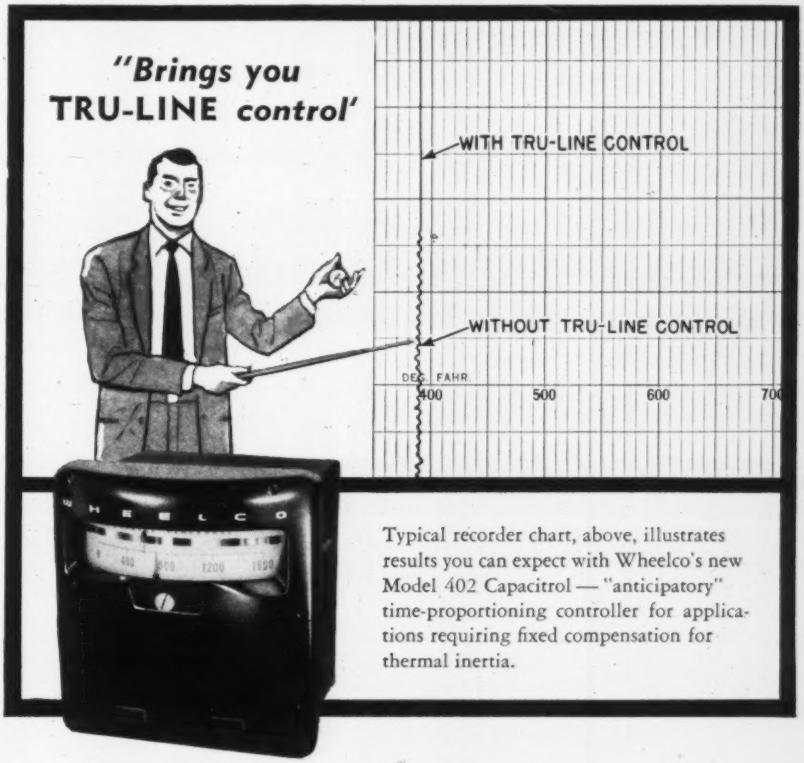
Self-balanced Indicator

New "Type DK Indicator" is a portable high-speed self-contained instrument fed from pressure, temperature,


4728

BARBER COLMAN

New Wheelco Model 402 Capacitrol



Typical recorder chart, above, illustrates results you can expect with Wheelco's new Model 402 Capacitrol — "anticipatory" time-proportioning controller for applications requiring fixed compensation for thermal inertia.

... totally new and accurate time-proportioning controller

If you want to minimize under- and over-shooting of temperatures in furnaces, ovens, and kilns . . . get more uniform heat distribution . . . or control rate of fuel flow . . . here's the newest and most advanced instrument for the job! For, "anticipatory" action of the "Model 402" is produced directly within the packaged *electronic* control unit. There's no disturbance to, or off-setting of the measuring circuit — indicator always gives you the correct temperature value. Proportioning band is adjustable to a maximum equivalent of 1% of scale. Total cycle time is adjustable from 5 seconds to 45 seconds.

NEED MORE INFORMATION?

Describes and illustrates new design features . . . new control forms . . . and new cost-saving flexibility of Wheelco's new 400 Series Capacitrols. Write for your copy of Bulletin F-6314-1 *today.*

Capacitrols

WHEELCO INSTRUMENTS DIVISION

Barber-Colman Company
Dept. R, 1515 Rock Street, Rockford, Illinois

BARBER-COLMAN OF CANADA, LTD., DEPT. Q, TORONTO, ONTARIO, CANADA
Industrial Instruments • Automatic Controls • Air Distribution Products • Aircraft Controls • Small Motors
Overdoors and Operators • Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

For more information circle **56** on inquiry card.

BOURNS
sub-miniature
TRIMPOTS
TRADE MARK

PROVIDE THE ULTIMATE IN CIRCUIT TRIMMING

Simple screwdriver adjustment...

The TRIMPOT is a 25-turn, fully adjustable wire-wound potentiometer, designed and manufactured exclusively by BOURNS LABORATORIES. Electrical settings in increments as small as ¼% are securely maintained during vibration of 20 G's up to 2,000 cps or sustained acceleration of 100 G's. BOURNS unique self-locking design eliminates cumbersome locknuts. Power rating is ¼ watt at 100° F. Standard resistance values from 10 ohms to 20,000 ohms are available for immediate delivery. Information on TRIMPOTs for high temperature operation on request.

BOURNS TRIMPOTs are accepted as standard components by aircraft and missile manufacturers and major industrial corporations.

9 TRIMPOTS TAKE LESS SPACE THAN A 2¢ STAMP

2 CENTS 2

Tiny cross-sectional size—only 1/4" x 5/16"—and rectangular shape save valuable panel space. Instruments are easy to mount individually or in stacked assemblies with two standard screws through the body eyelets.

BOURNS *also manufactures precision potentiometers to measure Linear Motion; Gage, Absolute, and Differential Pressure and Acceleration.*

BL

BOURNS LABORATORIES
6135 MAGNOLIA AVENUE • RIVERSIDE, CALIFORNIA
Technical Bulletin On Request, Dept. 22

© B L PATENTS PENDING

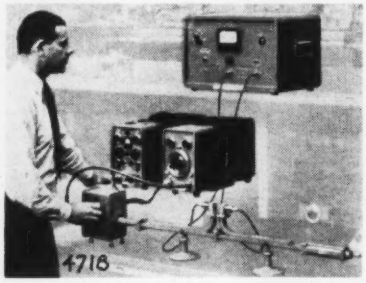
For more information circle **57** on inquiry card.

force or displacement pickups using 60-cps. linear variable differential transformers. Output of contained LVDT is automatically balanced against that of an external LVDT. Two-position rotary switch on front of case varies high range sensitivity automatically by a preset amount; calibration switch checks indicator zero at any time without interrupting process being checked.—*Schaevitz Engineering, Camden* 1, *N. J.*

For more information circle **287** on inquiry card.

Reflectometer System

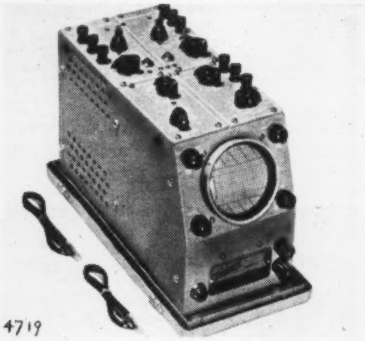
New reflectometer system capable of wide range microwave impedance measurements includes a new ratio meter, a 7 to 10 kMc. swept-frequency oscillator, a power supply, and related crystal detectors and directional couplers; makes possible direct and continuous swept-frequency oscilloscope presentation, production checking of reflection coefficient or SWR, etc.—*Hewlett-Packard Co.,* 395 *Page Mill Rd., Palo Alto, Calif.*


4718

For more information circle **288** on inquiry card.

Portable Oscilloscope

New "Model 385" lightweight 3-in. portable oscilloscope features a new 6-section unitized circuit construction for minimum interaction between amplifiers and sweeps; provides for replaceable circuit sections as individual units; is available as a portable, as a portable with moisture-proof carrying case or as a rack mount.—*Hickok Electrical Instrument Co.,* 10519 *Dupont Ave., Cleveland* 8, *Ohio.*


4719

For more information circle **289** on inquiry card.

Oscilloscopes

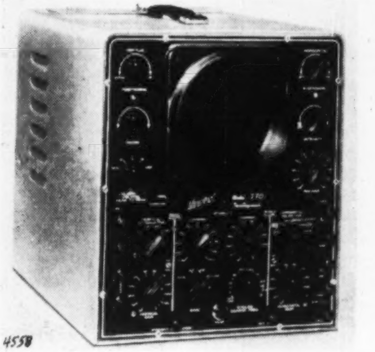
Two new a-c. oscilloscopes are said to feature wide bandwidth, high sensitivity and low price. Called "Models 701" and "701-D" (with delay line), they cover range of 5 cps. to 10 Mc. and are useful to 20 Mc. Sensitivity

16 mv. peak to peak per cm.; rise time 0.035 usec.; useful deflection 4 in.; triggered or recurrent sweeps from 0.1 to 10,000 usec. per cm.; high input impedance (2 megohms) paralleled by 25 mmf permits accurate measurements through low loading of tested circuit. Internal 1-kc. square wave available for calibration and adjustment of attenuators and probes. Cathode follower outputs for external gate and sweep connections provide synchronization for auxiliary equipment. On the "701-D," leading edges of pulses can be effectively displayed by delaying vertical signal through a 0.25-usec. delay line until sweep starts. —*Browning Labs., Inc.*, 750 *Main St., Winchester, Mass.*

For more information circle **290** on inquiry card.

5-inch Oscilloscope

New "Model 770" 5-inch oscilloscope features: vertical-amplifier response from 0 to 5 Mc (3db); horizontal-amplifier response from 0 to 500 kc (3db); sweep circuit frequency from 2 cycles to 30 kc; input impedance of 2.2 megohms; vertical-amplifier def. sens. of 0.01 rms v/inch; horizontal-amplifier defl. sens. of 0.075 rms v/inch; illuminated, calibrated screen; built-in calibrated voltages.—*Hickok Electrical Instrument Co.*, 10528 *Dupont Avenue, Cleveland* 8, *Ohio.*


4558

For more information circle **291** on inquiry card.

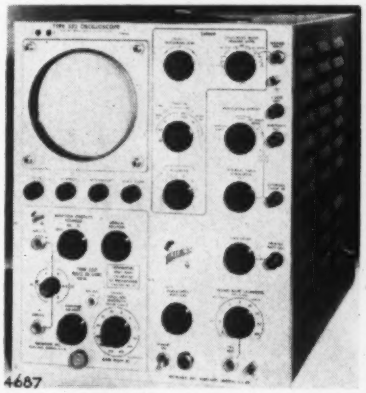
High-speed Oscilloscope

New "Type 336" cathode-ray oscilloscope is designed for precise measurements and analyses of phenomena at high rates of speed. Using internal standard, full-scale ranges extend from 1 volt to 500 volts. Sync shaper circuit permits differentiation of sync signal.—*Allen B. Du Mont Labs., Inc.*, 760 *Bloomfield Ave., Clifton, N. J.*

For more information circle **292** on inquiry card.

Oscilloscope

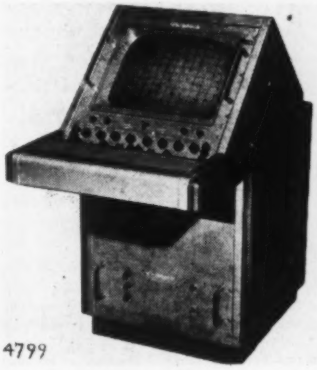
New "Type 532" offers advantages of all "Type 53" and "Type 53/54 Plug-In" units; is designed for users who do not need high-speed sweeps, high writing rate, and wide passband of "Type 531." Simplified circuitry eases vacuum-tube loading; lower accelerating potential reduces possibility of screen damage at very-slow sweep speeds and makes possible greater linear vertical deflection.—*Tektronix, Inc., P. O. Box* 831, *Portland* 7, *Ore.*


4687

For more information circle **293** on inquiry card.

Console Oscilloscopes

New "1700 Series" models of maker's CROs can be installed in modern console-type cabinet for maximal convenience of operator; feature 17-in. rectangular tube with face inclined for maximal viewing ease. Cabinet is steel, ventilated and with space for storage. Rubber-tired casters can be supplied for ease of mobility.—*Electromec, Inc.*, 3200 *N. Fernando Blvd., Burbank, Calif.*


4799

For more information circle **294** on inquiry card.

Quick-start Oscillograph

New "S14-E" is an improved version of "S14." Two kinds of chart-drive systems are now available: one employs miniature V belts; the other a continuously-variable transmission. Standard accessories include drum-

BARBER COLMAN

d-c motors

chosen to drive new Vought Photographic Recorders

Designed primarily for use on aircraft, the Vought 16 mm. Photographic Recorder takes up to 16 photos per second . . . and 4,000 individual pictures without reloading.

With its compact size . . . only 4" x 4¾" x 7⅝" . . . design of this recorder called for a highly efficient, geared-head driven motor that would occupy little space. For this a Barber-Colman type BYLM permanent-magnet motor was selected.

If you have a design problem that demands small size, d-c fractional hp motors of unusually high quality, high dependability, investigate the Barber-Colman line. Both permanent-magnet and split-series types . . . in various mountings and speeds with outputs up to 1/10 hp. Ideally suited to power electro-mechanical actuators, switches, blowers, programing devices, and various other applications . . .

THE VERSATILE LINE OF HIGH-QUALITY SMALL MOTORS

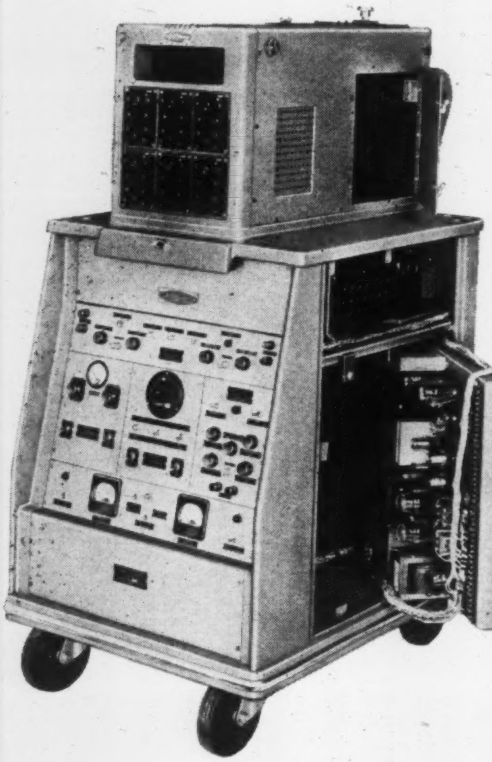
- Permanent-Magnet Motors
- Split-Series Motors
- Motors with Gearheads
- Motors with Filters
- Motors with Blowers

Write for free catalog No. 100

Barber-Colman Company

Dept. R, 1415 Rock Street, Rockford, Illinois

For more information circle **58** on inquiry card.



Multi-channel Recording D-C to 200 kc

Hathaway New SC-16B

The SC-16B is a complete oscillograph which records up to 12 signals on a single chart. It produces sharp, well defined records even at the highest frequencies. The SC-16B is useful in research programs requiring multi-channel, high frequency recording of pressure, strain, vibration, and acceleration.

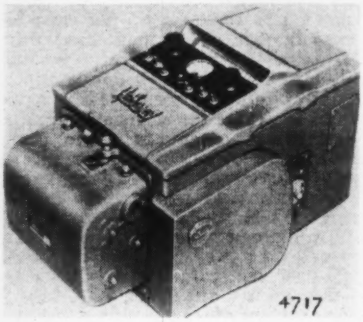
SPECIFICATIONS

Number of Channels: Up to 12 **Chart Speed:** 1.6 to 6000 inches per second **Chart Size:** 6 inches x 100 or 200 feet; 6 inches x 15 inches; 6 inches x 10 feet; 35 mm. x 400 or 1000 feet **Frequency Response:** D-C to 200 kilocycles **Writing Rate:** 5,000,000 inches per second **Chart Speed Change:** 16 speed quick-change transmission **Voltage Input Level:** 1.5 volts r.m.s. per inch on tube screen; 1.5 millivolts r.m.s. per inch on tube screen with type ASC-10 D-C Amplifier **Timing Lines:** Precision tuning fork controlled at 1/100 or 1/1000 second intervals **Synchronization:** Transient can be initiated from oscillograph, or transient can initiate oscillograph **Record Length Control:** For continuously-moving-chart recording, 0.75 to 15 seconds; for drum-type-chart recording, 5 milliseconds to 1 second.

Write for bulletin 2-G1-H

Hathaway
INSTRUMENT COMPANY DIVISION OF
Hamilton
WATCH COMPANY
1315 SOUTH CLARKSON • DENVER, COLORADO

For more information circle No. **59** on inquiry card.



4717

type record magazine, time coordinate device, and automatic transient-recording equipment capable of starting in 2 milliseconds.—*Hathaway Instrument Co.*, 1315 *S. Clarkson St., Denver* 10, *Colo.*

For more information circle **295** on inquiry card.

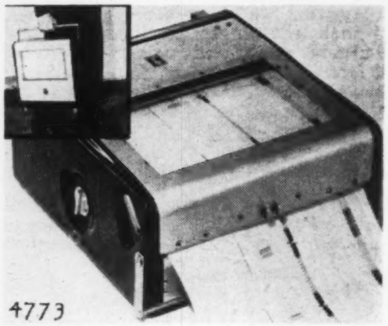
Small Oscillograph

New "Model 581," said to be "the smallest complete flight-test oscillograph available today," measures stresses, strains, vibrations, etc., under extreme acceleration, shock and temperature conditions. Among features: automatic record-numbering, automatic length-control (resettable by remote control), full-width timing lines at 0.01 and 0.1 sec., trace identification, paper speeds from 0.5 to 44.75 ips.—*Midwestern Instruments*, 3401 *S. Harvard, Tulsa, Okla.*

For more information circle **296** on inquiry card.

Portable Oscillographs

Two new lightweight oscillographs are announced: Four-channel unit weighs 36 lbs.; six-channel 48 lbs.



4773

Each provides full range instrumentation, offering 16 chart speeds from 10 in. per day to 10 ips.; either ink or electric writing; "can record a greater range of signals with optimum resolution than other direct-writing oscillographs."—*Brush Electronics Co.*, 3405 *Perkins Avenue, Cleveland* 14, *Ohio.*

For more information circle **297** on inquiry card.

Plastic-inkwell Recorder

New "Type CH" strip-chart recorder is portable, semiflush or surface-mounted models to record current, voltage, power, frequency or speed. Novel feature is throw-away inkwell: replacement ink is supplied in plastic inkwells containing 3 oz. (triple the amount normally contained in usual open-type well) delivered sealed for quick insertion with no spilling. Ink is

5
10
15
20
25
30
INCHES OF WATER

MARSHALLTOWN

DIAPHRAGM GAUGE

For Accurate Pressure Measurement in Ounces or Inches of Water

Available in standard dials (reading in inches of water) 0-15" -0-30" -0-60" -0-100" 0-160" . . . also in ounce graduated dials from 15 ounces to 5 pounds. 2½", 3½" and 4½" dial sizes mounted in black enameled steel case.

Marshalltown Figure 83 is an extremely sensitive gauge that uses a carefully seasoned bronze diaphragm to accurately measure very low pressures. It is used extensively on many types of natural gas installations for checking low pressures.

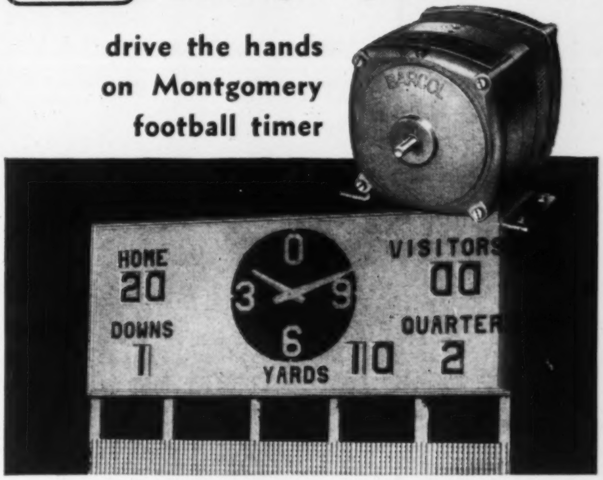
Write for details and price. LOOK TO MARSHALLTOWN FOR ONE OF THE MOST COMPLETE LINES OF INDICATING PRESSURE GAUGES MADE!

MARSHALLTOWN MANUFACTURING CO.
MARSHALLTOWN 3, IOWA

For more information circle **60** on inquiry card.

BARBER COLMAN **Small Motors**

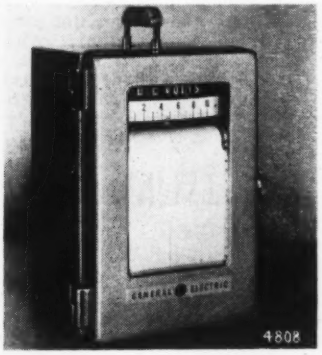
drive the hands on Montgomery football timer



Football timers with hands sweeping an eight-foot diameter, such as on the Montgomery timers, require highly dependable small motors with high starting torque. To meet these requirements, Montgomery Manufacturing Co., Owensville, Indiana, selected two types of Barber-Colman geared head motors: synchronous type PYAZ to drive the second hand mechanism, and type HYAZ to drive the minute hand. For precise operation of your product, too, there's a wide line of high torque Barber-Colman Small Motors . . . up to 1/20 hp . . . unidirectional, synchronous, and reversible . . . with or without reduction gearing. Write for data.

Barber-Colman Company Dept. R, 1215 Rock St., Rockford, Ill.

For more information circle **61** on inquiry card.

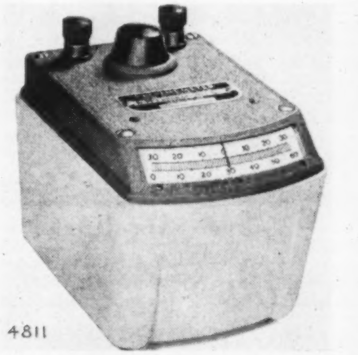

4808

all used before disposal of container because minute pen opening minimizes evaporation. Record roll length 150 ft.; 28 chart speeds from ¼ in. per hr. to 2 ips.; response time "as little as half a second." Choice of electric or 60-day spring clock chart drive. Case is weather-resistant with rubber-gasket-sealed door; is of die-cast aluminum. Portable model is 10.47 x 17.16 x 13 in.; others vary slightly.—*Instrument Dep't, General Electric Co., 40 Federal St., West Lynn 3, Mass.*

For more information circle **298** on inquiry card.

Galvanometers

New design and color styling is announced for maker's mirror and pointer type portable galvanometers. Illustration shows first such new model: housing is smaller than that of earlier "200 Series" models and, be-


4811

cause of its practical finish (two-tone gray wrinkle), shows little if any accumulation of dust, etc.—*G-M Laboratories Inc., 4300 N. Knox Ave., Chicago 41, Ill.*

For more information circle **299** on inquiry card.

ELECTRICAL INSTRUMENT ACCESSORIES

Dielectric Voltage Divider

New "Type PD-2 Dielectric Potentiometer" is a new-principle variable voltage divider which is free of phase and frequency distortion over range of 20 cps. to 10 Mc.; is a three-terminal network with a lossy liquid dielectric immersing the terminal electrode structure. Output electrode is mechanically mobile with respect to input electrode. Stopless movement through the liquid dielectric provides a smoothly continuous voltage division. Constant *RC* product of the two ratio arms assures the same voltage division for any and all frequencies within band range of device. Attenuation range is approx. 25 db, resolution is infinite, and input impedance over a wide range can be provided.—*Technology Instrument Corp., Acton, Mass.*

For more information cricle **300** on inquiry card.

Variable Attenuator

New "Tri-Plate" variable attenuator for coaxial lines features unique construction using a movable resistive card sandwiched within a new type of printed circuit transmission line; is designed for use as an uncalibrated pad in 1000-6000-Mc. range. For con-

VARIABLE ATTENUATOR
MODEL 1
4467

Instant Automatic Release of

Excess Pressure

Rupture Discs

The safety of your pressurized equipment and your personnel depends upon the precision and accuracy of your rupture discs. Baker's long experience in the handling and fabrication of metals to minute tolerances is your best assurance of a product that will perform to specifications. Baker rupture discs are available in base metals, and in corrosion-resistant precious metals. They are made to your order for pressures up to thousands of pounds.

Send for the free booklet, "Baker Rupture Discs." Information and data to help you select the type of disc that will give you absolute protection.

BAKER
rupture discs
BAKER

BAKER & COMPANY INC **PRECIOUS METALS**

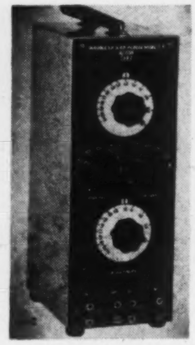
113 ASTOR STREET, NEWARK 5, N. J.
NEW YORK • CHICAGO
SAN FRANCISCO • LOS ANGELES

For more information circle 62 on inquiry card.

venience, dial carries approx. calibration reading directly in db at 3, 4 and 5 kMc.—*Sanders Assoc., Inc., Nashua, N. H.*

For more information circle **301** on inquiry card.

Audio-frequency Filter



New "Model 2-A Filter Set" is said to be first of its type for low-frequency applications from 15 cps to 10,000 cps. Passive network unit is continuously variable high-pass and low-pass audio-frequency filter. Equipment has only two controls for each group of filters. One control is a switch in octave steps, second control is a multiplier, making filter continuously variable between the octave steps on the switch. Attenuation outside of pass band is 30 db per octave. Handles 5 watts in a 600-ohm circuit. "Model 2-B Filter" covers frequency range of 60 to 20,000 cps.—*Allison Labs., 14185 Skyline Drive, Puente, Calif.*

For more information circle **302** on inquiry card.

Voltage Regulator

New "Stabiline Type TM" (Tubeless Magnetic) automatic voltage regulator holds output voltage to within one-volt band, has a speed or response of less than one second for full range correction. Maximum waveform distortion is 3 percent. Corrects for voltage input change from 95 to 135 volts; nominal output is 115 volts. Frequency range is 55 to 65 cps.—*Superior Electric Co., Bristol, Conn.*

For more information circle **303** on inquiry card.

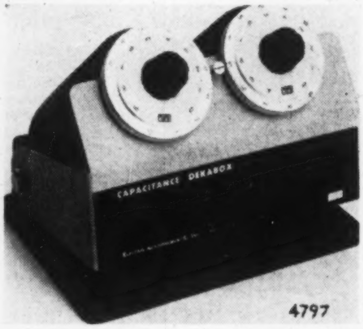
Squaring Circuit

New "Z-90049," designed to operate from 0 to 1 Mc, is intended to square input sine or complex waveforms; provides relatively fast rise and decay times; can also be used as a base and peak clipper.—*EECO Production Co., 827 S. Vermont Ave., Los Angeles 5, Calif.*

For more information circle **304** on inquiry card.

Capacitance Decade

New "Model DC-40 Dekabox" features low dissipation factor and straight-line readout (example in photo: "2458"). Four decade step switches provide coverage of 1-uf. capacitance range in ten thousand incremental steps of 0.0001 uf. each. Accurate capacitance selection is assured through use of precision components, "dry-filmed" ceramic switches having solid silver alloy contacts, and firm positioning switch detents.—*Electro-Measurements, Inc., 4312 S. E. Stark St., Portland 15, Ore.*



For more information circle **305** on inquiry card.

AMPLIFIERS and POWER SUPPLIES

Voltage Amplifier

New "Model 3400-A" is for use as a preamplifier ahead of electronic instruments. Is a direct-coupled two-stage amplifier having an output through a capacity network. Gain is approximately 100 to 100,000 cps and 50 at 200,000 cps.—*Electro Products Labs., 4503 N. Ravenswood Ave., Chicago 40, Ill.*

For more information circle **306** on inquiry card.

Measurement Amplifier

New "Model P" is an electronic linear amplifier designed to increase speed and accuracy of low-level direct voltage measurements; is basic instrument of maker's electropneumatic and electrohydraulic measurement and control systems; is completely compatible with inputs from thermistors, thermocouples, radiation receivers, thermal converters and d-c. strain gages; is available in multiple fixed and adjustable ranges; with fixed or adjustable zero suppression circuits.—*Hagan Corp., 323 4th Ave., Pittsburgh 22, Pa.*

For more information circle **307** on inquiry card.

Magnetic Amplifier

New "Constrained Bridge Model 505-1" features high power efficiency, low quiescent power consumption and freedom from zero drift due to change in rectifier characteristics; is applicable to instrument servo applications where close packaging requires minimum size and where unit force cooling is not possible. Efficiencies up to 90 percent are possible for response lags of a few cycles of power frequen-

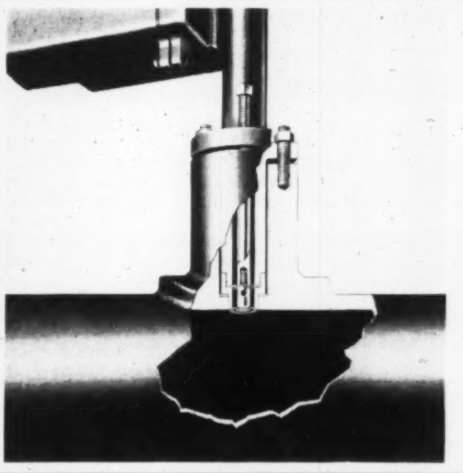
***Another Swartwout Development in Instrumentation for Better Quality Control**

SWARTWOUT
AUTRONIC CONTROL SYSTEMS

Precise pressure measurement without line impedance or temperature effects . . . without filled systems—that's the new Swartwout P3T Flush Diaphragm Pressure Transmitter*. And since this new pressure transmitter eliminates heat jacketing or tracer lines . . . stagnant pressure lines or fluid seals, it's ideal for use with such hard-to-handle fluids as asphalts, high-temperature or viscous liquids, molten metals, slurries and polymers. The P3T pressure transmitter operates in process temperatures up to 1200°F . . . has sensitivity of .005%, reproducibility of .1%, accuracy of 1%. Standard units for ranges up to 10,000 psig, higher pressures on special order. Full details on request to your Swartwout representative, or request Bulletin A-713.

New flush diaphragm pressure transmitter

eliminates stagnant pressure lines without heat jacketing



◀ **Cutaway section** shows how pressure acts against diaphragm mounted flush with inside of process pipe. Force is transmitted through rod to amplifying linkage which moves core of a differential transformer, transmits an electric signal to Autronic Controller or Recorder.

Autronic Controller or Recorder is used with P3T Flush Diaphragm Transmitter. Signal from pressure transmitter is directly proportional to pressure being measured. Since no slide wires, boosters, motors, etc., are used, response of the Autronic System is instantaneous and accurate. ▶

ON
OFF
RESET RATE
RESET
AUTRONIC CONTROL
PAT. APP. FOR
THE SWARTWOUT CO.
CLEVELAND, OHIO
PROP BAND
RATE TIME
RELEASE
LOCK

AA-1342

Swartwout Autronic® CONTROL SYSTEM

THE SWARTWOUT COMPANY · 18511 EUCLID AVENUE · CLEVELAND 12, OHIO

For more information circle **63** on inquiry card.

Engineering Writing

for Advancement in Electronics

If you are an Electrical Engineer or Physicist with aptitude for writing, here is a way to broaden your experience and enter a fascinating area of advanced electronics in one of the nation's leading organizations in its field . . .

Hughes Engineering Writers

work directly with design, development, test and maintenance engineers—performing the vital work of transforming complex theory and procedure into clear, concise technical information contained in manuals, handbooks and other publications for use by military and civilian technical people.

Here are some of the advantages of being an Engineering Writer at Hughes:

- Training at full pay to become familiar with Hughes-developed and manufactured radar, computer systems and guided missiles.
- Full status as a member of the Hughes Technical Staff, with same Company benefits.
- A salary commensurate with other Engineering categories.
- Close personal liaison with project engineers.
- Career permanence, with assured advancement opportunities.
- Reasonable traveling and moving expenses. Live and work in Southern California.

Write, giving education, experience and other qualifications, to:

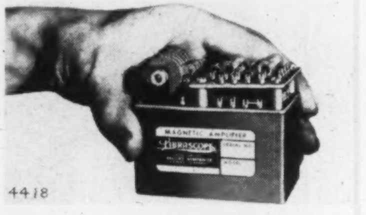
HUGHES

RESEARCH & DEVELOPMENT LABORATORIES

SCIENTIFIC AND ENGINEERING STAFF

Culver City, Los Angeles County, Calif.

For more information circle **64** on inquiry card.



cy. Bias current is not needed in this system, whence further stability.—*Librascope, Inc., 808 Western Ave., Glendale, Calif.*

For more information circle **308** on inquiry card.

Miniature Amplifier

New "Type 338 Transistor Preamplifier" can amplify one thousand times electrical signals whose power is a billionth of a watt; generates almost no electrical noise of its own which might distort signals; is operated by four mercury cells, about the size of four shoe buttons, which last 1000 hours.—*Allen B. Du Mont Labs, Inc., 760 Bloomfield Ave., Clifton, N. J.*

For more information circle **309** on inquiry card.

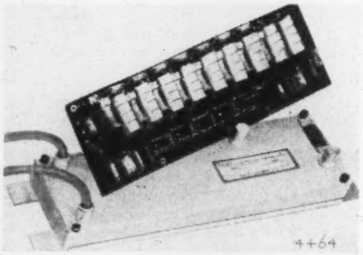
Preamplifier

New "Model 3400-A" is low-cost voltage amplifier intended for use as a preamplifier or as all-purpose laboratory-type voltage amplifier. Two stages; gain of 200 at frequencies between 1 and 30,000 cps. Peak-to-peak output is 10 volts. Time constant of output network permits satisfactory operation at frequencies down to 1 cps.—*Electro Products Labs., 4503 N. Ravenswood Ave., Chicago 40, Ill.*

For more information circle **310** on inquiry card.

I-f. Amplifiers

New miniature light-weight i-f. radar amplifiers incorporate low-noise front ends. New techniques, materials and methods are employed to provide, for example, a nine-tube completely-enclosed amplifier that measures 8½ x 3 x ¾ in. and weighs 1 lb. Automatic and/or manual gain control 100 db or greater: noise figures better than 2 db; ambient temperature –65 C. to 100 C.; withstand 30 *G* shock and 10 *G* vibration for extended periods.—*RS Electronics Corp., 435 Portage Ave., Palo Alto, Calif.*



For more information circle **311** on inquiry card.

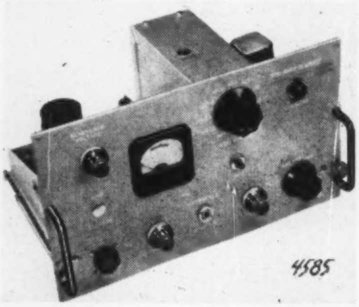
500-Watt Amplifier

New "T-11" linear power amplifier, designed for high power outputs in cw, am and single side-band operation at 75, 40, 20, 15, and 10 meters, provides low harmonic output, excellent stability and freedom from parasitics; is mounted in a 21 x 15 x 12 in. metal cabinet with self-contained heavy-duty power supply; weighs 80 lbs.—*Transitron, Inc., 154 Spring St., New York 12, N. Y.*

For more information circle **312** on inquiry card.

Preamplifier

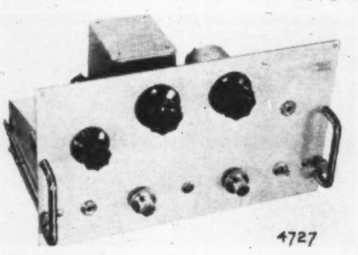
New "Model 150-1200 Servo Monitor Preamplifier" is a phase-discriminating a-c amplifier. Basic sensitivity is 10 mv/cm. Input voltage range is 50 mv to 50 volts; frequency range is 60 cycles to 10 kc.—*Sanborn Co., Ind. Div., 195 Massachusetts Ave., Cambridge, Mass.*



For more information circle **313** on inquiry card.

Log-audio Preamplifier

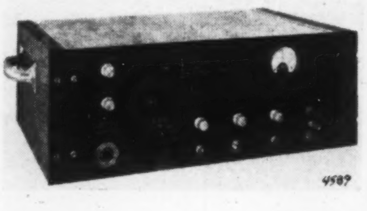
New "Model 150-1400" log-audio preamplifier, used with a basic "150" oscillographic recording assembly, permits recording in either linear or decibel values, with a basic sensitivity of 1 db/mm. deflection, a selection of d-c. input signals or audio (20 to 20,000 cps) input signals.—*Sanborn Co., Industrial Div., 195 Massachusetts Ave., Cambridge, Mass.*

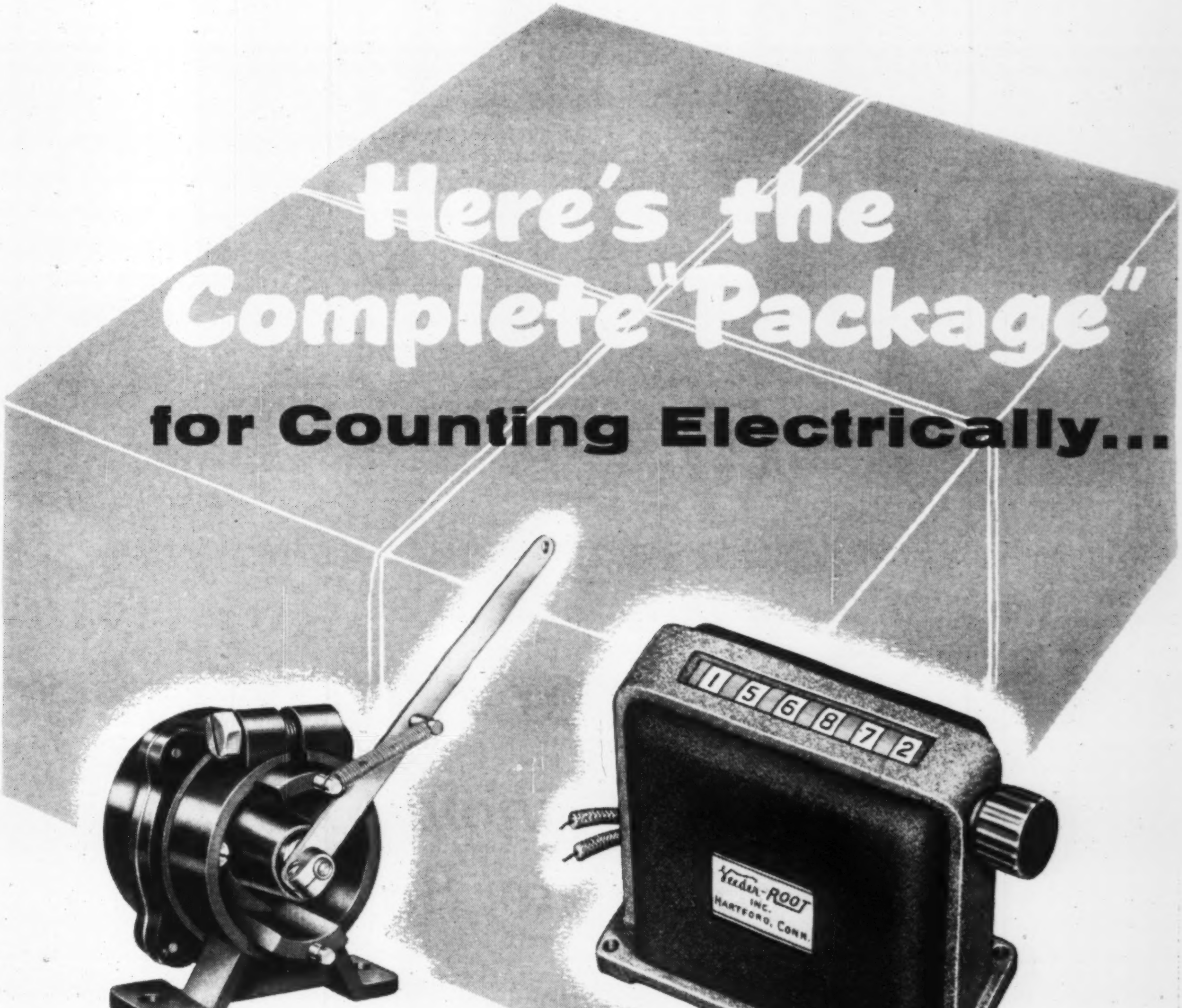


For more information circle **314** on inquiry card.

D-c. Amplifier

New "Model D-1" direct-coupled amplifier has gain of 80,000; frequency response is flat from zero to more than 100 kc at gain settings up to 10,000. High input impedance enables





Here's the Complete "Package" for Counting Electrically...

Added Evidence that —

Everyone Can Count on VEEDER-ROOT

This Veeder-Root Reset Magnetic Counter (AC or DC) is actuated through electromagnets. And it may be connected in series with any device having a contact arrangement . . . like the specially designed Veeder-Root Electrical Contactor at the left, which insures positive operation of the counter, either in oscillation or connected directly to a revolving shaft . . . with the counter placed at *any* distance from the machine or process on which the count is required.

This is another one of the hundreds of Veeder-Root Standard and Special Counting and Computing Devices developed for every conceivable counting duty, in every field from atomics to electronics.

What do *you* need to count? Just write:

VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities
"The Name that Counts"

For more information circle **65** on inquiry card.

BROWN PRESSURE GAGES

Rugged, powerful design. Ample sizing of parts gives liberal overload protection . . . yet provides high sensitivity to small changes without tapping error.

Ranges from vacuum to high pressure. Standard ranges cover the pressure spectrum from 5" of water to 4,000 psi.

Choice of measuring elements . . . includes spirals, spring and bellows (intermediate and low-range) and dual spring and bellows for absolute pressure . . . all designed for fast, accurate response and long life.

Variety of models. Indicators, recorders (with one, two or three pens) with or without electric or pneumatic control . . . also available as pneumatic transmitters or receivers for remote measurement.

Variety of control actions. Electric control systems include on-off, two-position and three-position with adjustable neutral. Pneumatic control types are on-off, 10% *Throttlor, Full Throttlor, Air-O-Line* (proportioning-plus-reset) and *Air-O-Line* with rate action.

Spiral

Whatever your need

take your choice from the complete Brown line

BROWN THERMOMETERS

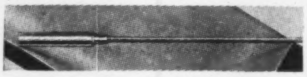
Variety of thermal systems. Mercury, gas and vapor systems cover temperature ranges from —125 F. to 1000 F.

Thoroughly compensated. Gas and mercury systems correct themselves automatically for variations in ambient temperature.

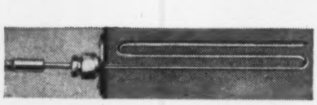
Variety of models. Indicators, recorders (with one, two or three pens), controllers, pneumatic transmitters and receivers, single-unit indicating controllers, and program controllers are available in a choice of standard and special types.

Variety of control actions. Electric control systems include on-off, two-position and three-position with adjustable neutral. Pneumatic control types are on-off, 10% *Throttlor, Full Throttlor, Air-O-Line* (proportioning-plus-reset) and *Air-O-Line* with rate action.

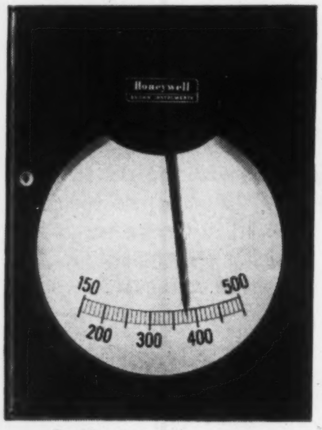
Variety of bulbs and accessories. A wide selection of bulbs, wells, and tubings of various materials and designs plus related accessories cover a complete range of application requirements.



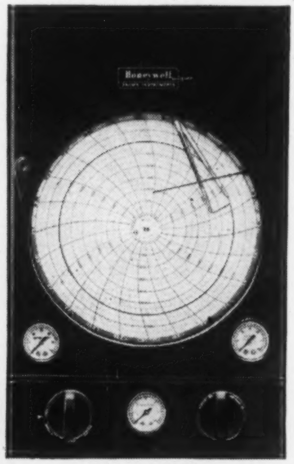
Regular bulb



Averaging bulb

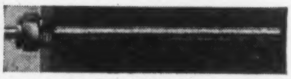


Indicating thermometer



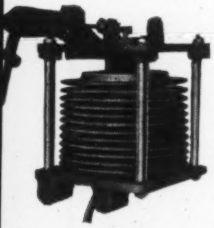
Air-control recording thermometer

Capillary bulb



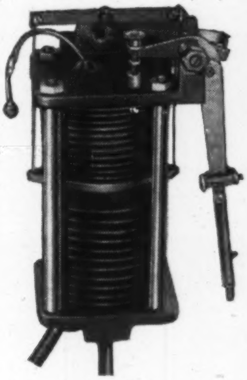
Rigid bulb

For more information circle **66** on inquiry card.

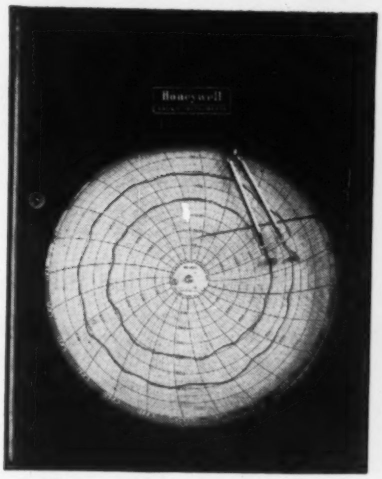


Low range bellows

Intermediate range bellows



Absolute pressure unit



2-pen recording pressure gage

Electric control recording pressure gage

for temperature or pressure

WHENEVER production processes need thermometer or pressure gage instrumentation . . . take a look at what Brown has to offer. You'll find an extensive selection from which to choose . . . just about every range, control action and performance feature you could demand . . . at prices that fit any instrumentation budget.

Continued development has brought these rugged, versatile instruments to a high level of performance. They have earned a reputation throughout industry for their ability not only to deliver accurate, sensitive service . . . but, equally important, to stay on the job with an absolute minimum of attention. Behind them stands the long design and production experience of the world's largest manufacturer of controls, and the assurance of prompt, competent service from a nationwide organization of instrument service specialists.

Multiple pen recording models of these versatile instruments are available. They can provide single chart recording of flow and temperature, temperature and pressure, or flow, temperature and pressure, with control on any one of the variables involved.

Ask your local Honeywell sales engineer to talk over your own process problems where these instruments can be advantageously applied. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA: Write for Catalog 6709, "Remote Bulb Thermometers" . . . and Catalog 7001, "Pressure and Vacuum Gages."**

H
HONEYWELL

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

First in Controls

For more information circle **66** on inquiry card.

below 800° F.

Accurate TEMPERATURE READINGS in a few seconds . . .

XACTEMP

Low Temperature - General Purpose HAND PYROMETER

Type LT-840 Low temperature Xactemp Pyrometer with rigid extension arm and surface tip thermocouple.

1001 USES

This is the answer to quick, accurate temperature readings below 800° F. in many industrial processes and operations. And it's so convenient to handle.

The Xactemp hand-type pyrometer, Model LT-840, is used with needle thermocouples, ribbon thermocouple, surface tip thermocouple, and other specially designed thermocouples and extension arms. These are easily interchangeable and, without adjustments or recalibration of the instrument, quickly ready it for measuring the surface temperature of stationary and revolving rolls and cylinders, flat and irregular surfaces of molds, dies, etc. in rubber and paper making, plastic materials, rubber, wax, oils, greases, and other semifluid materials.

Handy, compact design makes this Xactemp pyrometer ideal for field service, laboratory, and production-line use.

***Price** Xactemp Pyrometer less thermocouples* $56.50

Write for detailed, descriptive literature on Gordon Xactemp Pyrometers.

5646

GORDON SERVICE

CLAUD S. GORDON CO.

Manufacturers & Distributors

Thermocouple Supplies • Industrial Furnaces & Ovens
Pyrometers & Controls • Metallurgical Testing Machines
609 West 30th Street, Chicago 16, Illinois
2025 Hamilton Avenue, Cleveland 14, Ohio

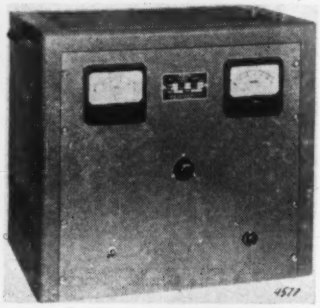
For more information circle **67** on inquiry card.

"D-1" to amplify a wide variety of input signals for recording, etc.—*Southwestern Industrial Electronics Co., 2831 Post Oak Rd., Houston, Texas.*

For more information circle **315** on inquiry card.

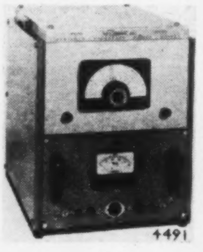
D-c. Power Supply

New "Model G125-25" is 125-volt 25-ampere germanium-rectifier d-c power supply. Inherent regulation is 4 percent from no load to full load.—*Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.*



For more information cicle **316** on inquiry card.

Variable-frequency Supply



New "VFS-250" is a self-contained source of 45 to 2000 cps. a.c. with available output up to 300 va. Flexibility of voltage, frequency and power output make this frequency changer suitable for (1) testing; (2) powering choppers, vibrators, etc.; (3) controlling synchronous motors and processing equipment.—*Vectron, Inc., 400-20 Main St., Waltham 54, Mass.*

For more information cicle **317** on inquiry card.

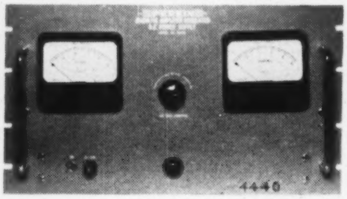
Dual Power Supply

New "Model D3-300D" power supply provides two high-voltage output ranges, each independent of the other—on one compact chassis. Delivers 0-300 v dc at 300 ma max. load and 0-300 v dc at 150 ma also variable bias 0-150 volts at 5 ma (regulated by VR tube), and 0-10 v ac, unregulated, at 10 amps, variable with "Powerstat" control. Regulation: for line voltage change of 10 percent, output voltage change is 0.15 percent for regulated high voltage. Both positive or negative of either high-voltage outputs may be grounded.—*Dressen-Barnes Corp., 250 N. Vindeo Ave., Pasadena 8, Calif.*

For more information circle **318** on inquiry card.

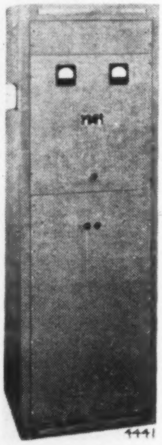
Mag-amp.-reg. Supply

New 6-v. 5-amp. tubeless magnetic amplifier regulated power supply has a d-c. output of 6 v. plus or minus 10 percent continuously and is magnetic amplifier regulated to 1 percent for a-c. line input changes of 95-130 v. as well as for d-c. load changes from 10 percent to full load. Response time 0.2 sec. maximum; ripple 1 percent.—*Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.*



For more information circle **319** on inquiry card.

25-kw. Tubeless Rectifier



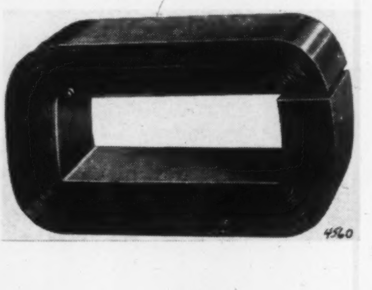
New type of 25-kw-rectifier power supply unit rated at 230 v.dc. output when operated from a 230-v. 3-phase 60-cps. a-c. input, has 15 percent inherent voltage regulation and 5 percent maximum ripple.—*Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.*

For more information circle **320** on inquiry card.

ELECTRICAL and ELECTRONIC COMPONENTS

Magnetic Core

New "Hyflux" one-piece wound core is said to be first of its type on market. Instead of vacuum impregnating the core with a plastic and cutting it into two pieces, sides of these cores are varnished and only one cut is made on corner. Advantages: (1) one gap improves performance, (2) less loss of electrical properties after vacuum impregnating with a plastic, (3) low price; (4) from 20 to 30 percent more efficient than sheared or punched cores. All cores are magnetically tested at three flux densities—10,000, 15,000, and 17,000 gauss.—*Indiana Steel Products Co., Valparaiso, Ind.*



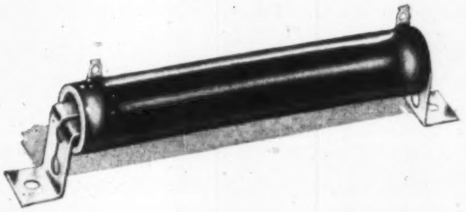
For more information circle **321** on inquiry card.

Thyratrons

New "ELC4J" and "ELC4JF" are xenon-filled thyratrons for application in motor control and ignitor firing circuits. Rating 4 amps. dc. continuous

For Dependability in Critical Circuits . . .

Specify MALLORY Resistors

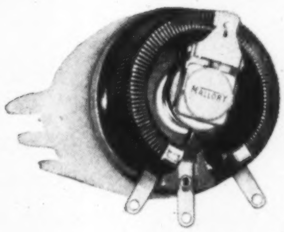


Vitreous Enamel Resistors

For use as dropping resistors, voltage dividers, etc., Mallory vitreous enamel resistors are rated for continuous duty at ambient temperature of 65°C. Long service and excellent stability are the results of using highest quality ceramic core, wire and enamel coating. Fixed and adjustable in ratings from 5 to 200 watts.

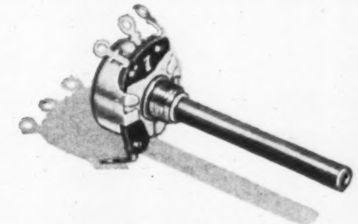
TO meet the increasingly stringent demands of modern instrument circuits, Mallory offers an extensive line of top-quality fixed and variable resistors. Used for years by leading manufacturers of electronic equipment, these components can be relied upon for stability, precision and long service life to meet your most exacting specifications . . . at economical cost.

In addition to the standard lines of resistors shown here, Mallory supplies a number of types of adjustable wire-wound resistors, and high power rheostats. For technical information on any of these, and for engineering assistance in their use in your own circuits, write or call Mallory today.



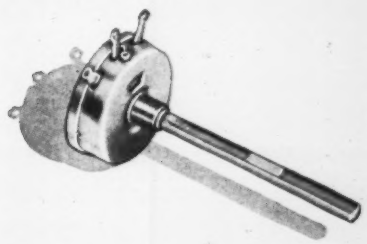
Power Rheostats

Especially useful in instrument circuits is the Mallory 25-watt rheostat. Exclusive hinged contact arm permits inspection or cleaning of brushes without changing contact pressure. Tapered windings are produced by a special variable pitch winding method that eliminates welded joints and hot spots. Other ratings up to 500 watts are available.



Variable Carbon Controls

Only $\frac{15}{16}''$ in diameter, these carbon controls fit readily into crowded chassis layouts. A special Mallory process produces resistance elements with high stability and minimum drift under adverse climatic conditions. Electrical noise is exceptionally low. Available in a complete range of tapers and resistance values, in both single and dual types.



Wire-Wound Controls

Famous for long service and superior performance, Mallory wire-wound controls cover the range from 2 to 7 watts, in resistances from $\frac{1}{2}$ to 150,000 ohms. Single, dual and triple sections and "T", "H" and "L" pad attenuators are available, with linear or special tapers.

Parts distributors in all major cities stock Mallory standard components for your convenience.

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

Expect more . . . Get more from

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

For more information circle **68** on inquiry card.

Genisco Rate-of-Turn Tables facilitate fast, precise calibration and evaluation of rate gyros

Ball-disc integrator drive provides infinitely variable rates from 0.01° to 1200°/sec.

EXTREMELY ACCURATE... constancy of angular velocity of the turntable is within 0.1%, including wow and drift errors, at any rate.

SMOOTH, CONSTANT ROTATION... unique synchronous motor, designed specially for this application, has large diameter rotor; high polar inertia.

EASY TO OPERATE... single handwheel controls turntable speed. Inexperienced personnel can operate machine after few minutes instruction.

IDEAL FOR LARGE VOLUME TEST PROGRAMS... ruggedness, simple operation, repeatability, and versatile mounting facilities make it the ideal machine for production-line testing.

PRECISE REPEAT POSITIONING... within 0.2% in same rotational direction; 0.5% in opposite direction, under 500° per second.

LOW ELECTRICAL NOISE LEVEL... better than –55 dbm per slip ring circuit (zero dbm = 1 mw in 600 Ω).

UNUSUALLY RUGGED... built to take years of continuous use; requires only minimum amount of maintenance.

TABLE CAPACITY... 100 pounds.

ACCESSORIES INCREASE ITS USEFULNESS!

SUB-RANGE ADAPTER... extends low range of Genisco Rate-of-Turn Table to 0.0001° per second.

PRECISION STROBE UNIT... for use in areas where accuracy of line frequency is questionable, or for calibration of gyros with accuracies better than line frequency.

MOUNTING STANDS... available in portable and fixed models.

Send today for complete specifications. Please direct your inquiry to Contracts Manager, Genisco, Incorporated, 2233 Federal Avenue, Los Angeles 64, California.

RELIABILITY FIRST

Genisco
INCORPORATED

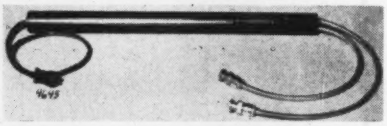
For more information circle **69** on inquiry card.

average anode current; 30 amps. oscillograph peak current with maximum peak forward and peak inverse of 900 v.; average arc drop 12 v.; heating time 60 sec.; critical grid current less than 10 uamp.—*Electrons, Inc.,* 127 *Sussex Ave., Newark* 3, *N. J.*

For more information circle **322** on inquiry card.

Traveling-wave Tube

New traveling-wave tube features broadband operation (4 to 8 kilomegacycles) without necessity of making any electrical or mechanical adjustments. Grid control is provided for variable-gain and power-output applications. Gain is 30 db and output is 10 milliwatts. Unit requires a 300-gauss field and 700-volt regulated power supply.—*Huggins Labs., Inc.,* 711 *Hamilton Ave., Menlo Park, Calif.*



For more information circle **323** on inquiry card.

Airborne Radar Klystron

New "VA-203" low-cost reflex klystron is said to feature superior frequency stability for airborne X-band radar receiver and beacon local oscillator service, and to be the most advanced klystron ever developed for airborne applications. It withstands shocks of 50 to 100 *G* without malfunction or damage. Among exclusive characteristics are negligible microphonics, slow tuning rate, long tuning life and a single shaft tuner which adapts easily to motor tuning.—*Varian Associates,* 711 *Hansen Way, Palo Alto* 2, *Calif.*

For more information circle **324** on inquiry card.

Silicon Power Rectifier

New silicon power rectifiers are capable of continuous operation at full rated power at an ambient temperature of 125 C. High forward conductance and extremely low leakage current allow operation at efficiencies up to 98 percent. Units are designed for conduction cooling. It is said that "these rectifiers do not exhibit forward aging effects."—*Transitron Electronic Corp., Melrose* 76, *Mass.*

For more information circle **325** on inquiry card.

Silicon Power Rectifiers

New "Type CK775" and "Type CL776" silicon power rectifiers can handle up to 15 amperes and 200 volts peak. Operation at 5 amperes and 170 deg C is permissible. Ratio of reverse to forward resistance is over 100,000; rectifier is small (about 0.6 cubic in.), hermetically sealed, and usable to over 100,000 cycles.—*Raytheon Mfg. Co.,* 55 *Chapel St., Newton* 58, *Mass.*

For more information circle **326** on inquiry card.

Germanium Rectifiers

New germanium rectifiers for d-c power supplies are oil immersed. Fully motorized, continuously variable, inductor controls are furnished to vary output from zero to full rated load at touch of a button. In voltage stabilization tests, minimum voltage variation of less than ±1 volt has been maintained when operating from no load to full load.—*Rapid Electric Co.,* 2881 *Middletown Rd., New York* 61, *N. Y.*

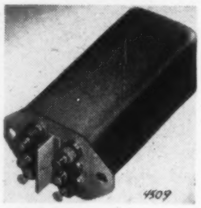
For more information circle **327** on inquiry card.

Component Rectifiers

New "Vac-u-Sel" line includes rectifier cells with a peak inverse rating of 63 volts, cells which will operate up to 130 C. ambient temperature, and cells with a life expectancy of 60,000 hours. It comprises 26-v. low-temperature cells, 26-v. high-temperature cells, and 45-v. high-temperature cells; all three produced by vacuum evaporation process permitting greatest control over contaminants affecting quality of finished rectifiers.—*Rectifier Dep't, General Electric Co., Schenectady* 5, *N. Y.*

For more information circle **328** on inquiry card.

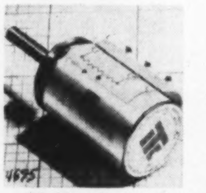
Electronic Chopper



New "Model 307 Chopper" is able to modulate dc to frequencies up to 400 cps, for minimum life period of 3000 hours. Has no moving parts. Modulation is accomplished by illumination of photoconductive element in typical voltage divider.—*Avion Instrument Corp.,* 299 *State Highway No.* 17, *Paramus, N. J.*

For more information circle **329** on inquiry card.

Precision Voltage Divider



New "L10S" miniature 10-turn voltage divider features linearity of 0.05 percent standard and 0.025 percent as a special tolerance where required. —*Technology Instrument Corp.,* 531 *Main St., Acton, Mass.*

For more information circle **330** on inquiry card.

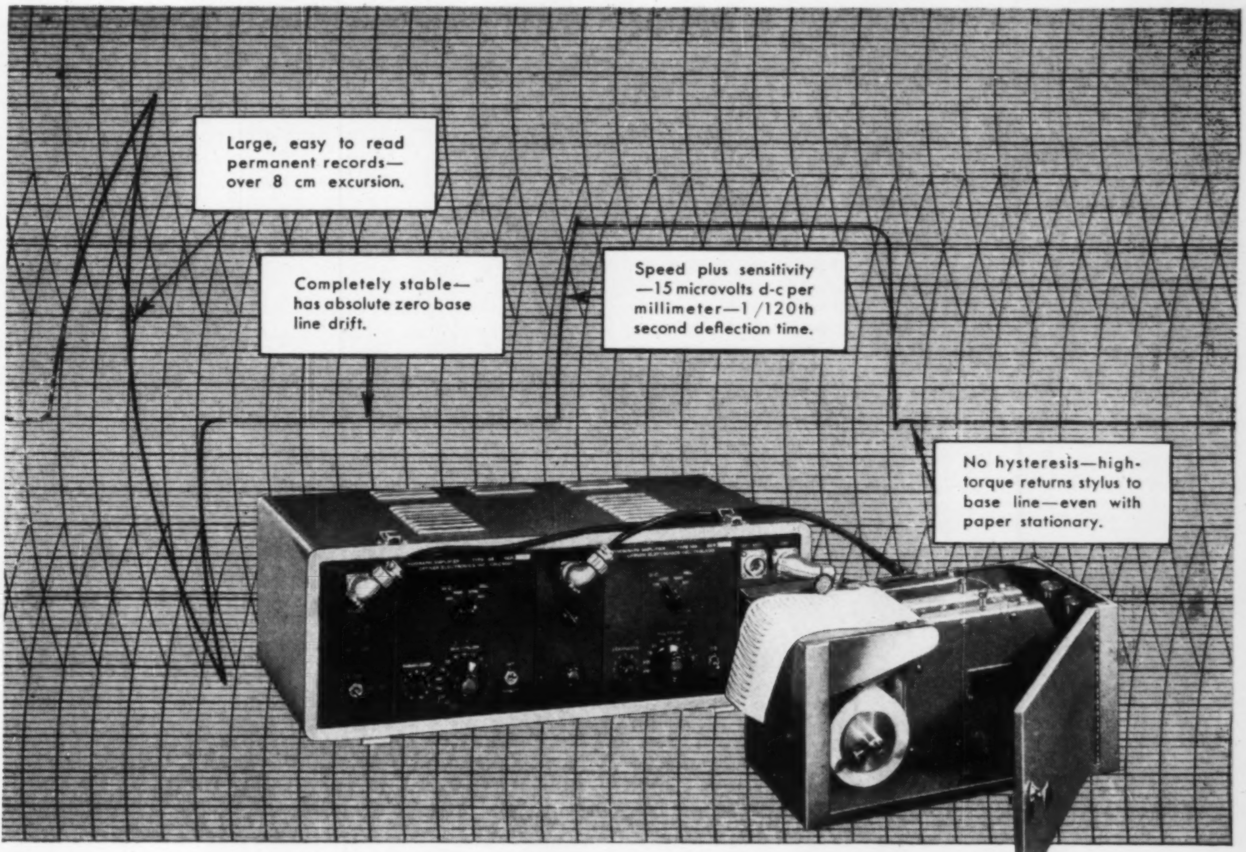
Non-linear VDRs

New "Series V Helipot" voltage-dividing resistors are engineered especially to meet non-linear requirements. As many as 25 can be ganged on a common shaft during manufacture, while 13 tap connections can be added to each pot by using maker's exclusive process. Size: 1¾-in. diam. by 0.8-in. long, with ¼-in. shaft; external clamps for rapid phasing even after installation. Operating range –55 C. to 90 C. Power rating above 5 watts at 25 C., above 4 watts at 40 C., 2.5 watts as high as 60 C. Resistances up to 130,000 ohms. Mechanical rotation 360 deg. continuous; maximum electrical contact angle 345 deg.; effective electrical rotation 325 deg.—*Helipot Corp.,* 916 *Meridian Ave., South Pasadena, Calif.*

For more information circle **331** on inquiry card.

Dual Cosine VDR

New "Model 35000" dual cosine voltage dividing resistor with accuracy of 0.04 percent consists of two electrically isolated potentiometers driven



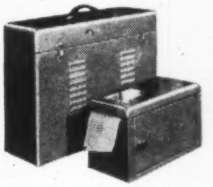
Large, easy to read permanent records—over 8 cm excursion.

Completely stable—has absolute zero base line drift.

Speed plus sensitivity—15 microvolts d-c per millimeter—1/120th second deflection time.

No hysteresis—high-torque returns stylus to base line—even with paper stationary.

NEW...OFFNER PORTABLE DYNOGRAPH



This high speed, direct writing oscillograph recorder provides exceptionally high, absolutely stable, d-c or a-c amplification. It may be used with reluctance type gauges without auxiliary equipment. The exceptional stability, sensitivity, and versatility of the Dynograph are made possible by the exclusive, patented chopper amplifier. It is used for recording a wide variety of transient variables, such as strain, vibration, temperature, analog computer write-out, etc.

The performance specifications of the Type P Portable Dynograph are identical with those of the Type M Console model, but it is mounted in two convenient carrying cases as illustrated. The Type P is available with one or two channels.

Write for your copy of Bulletin L-742. It gives you complete details and application information on both portable and console models of the Offner Dynograph.

Check these exclusive features:

Speed plus sensitivity. The Dynograph gives you the maximum in speed and sensitivity—15 microvolts d-c per millimeter deflection with a response speed of less than 1/120th second.

Large easy-to-read records. Over 8 cm excursion, permitting the recording of large dynamic variations. Chart speeds 1 to 100 mm per second.

Absolute non-drifting stability. The Dynograph is absolutely stable and non-drifting—it is stable when it starts working and has absolutely zero base line drift.

No Hysteresis. The high-torque movement always returns the stylus to the base line—even with the paper stationary. Linearity is within one percent for four cm.

OFFNER ELECTRONICS INC.

5326 N. Kedzie Avenue, Chicago 25, U.S.A.

For more information circle **70** on inquiry card.

TIC's New 800A

EXTENDED RANGE

VACUUM TUBE VOLTMETER*

A MEASUREMENT LABORATORY IN ONE COMPACT INSTRUMENT

featuring

- Wider ranges of current, voltage and resistance
- High accuracy
- Portability
- Very high stability
- Wide frequency range
- Rugged construction

UNMATCHED IN RANGE

DC and AC Volts a full decade lower (0.1V to 1000V, full scales)

Resistance values a full decade lower and higher (0.02 ohms to 5000 megohms)

Current values from 1 millimicroampere to 100 MA (full scales)

*Patents applied for

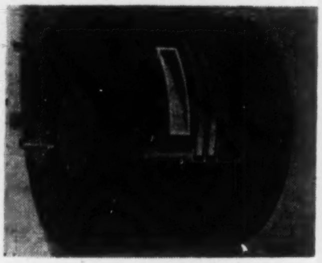
Write for FREE brochure and Laboratory Report No. 16

TECHNOLOGY INSTRUMENT CORP.

549 Main Street, Acton, Mass. COlonial 3-7711
P. O. Box 3941, No. Hollywood, Calif. POplar 5-8620

For more information circle 71 on inquiry card.

NEW INSTRUMENTS



from the same shaft, with individual output proportional to the cosine of shaft rotation. Is available with resistance values as high as 200,000 ohms.—*Gyromechanisms, Inc., Halesite, L. I., N. Y.*

For more information circle **332** on inquiry card.

Pulse Transformer

New "H75-11" two-winding epoxy-resin-impregnated and hermetically-sealed 75-usec. pulse transformer has a risetime of 2 usec.; meets MIL-T-27. Operating temperature range is from −70 C. to 135 C. Size: ⅞ x ⅞ x 1⅛ in. exclusive of terminals and mounting flange.—*The Gudeman Co. of California, Inc., 9200 Exposition Blvd., Los Angeles 34, Calif.*

For more information circle **333** on inquiry card.

Variable Delay Line

New "Type 605" comprises 60 sections of *LC m*-derived networks and one 60-position rotary switch. Accuracy of time delay can be as high as 0.5 percent at any point. Five different types available, with maximum time delays from 0.6 to 12 usec.—*Advance Electronics Co., Inc., 451 Highland Ave., Passaic, N. J.*

OUTPUT
INPUT

For more information circle **334** on inquiry card.

ELECTROMECHANICAL COMPONENTS

Aircraft Inverter

New "Model SE-16-2" aircraft inverter has a rating output of 250 va., 3-phase or single phase, at altitudes up to 50,000 feet and a half-load rating up to 65,000 feet. Is self-cooled, but readily adaptable to blast cooling.—*Leland Electric Co., Div. of American Machine & Foundry Co., Dayton 1, Ohio.*

For more information circle **335** on inquiry card.

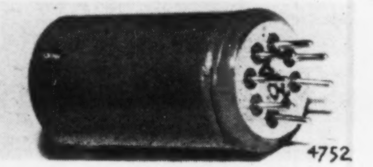
Compensated Resolver

New compensated resolver is first of size 11. (Size 23 and 15 resolvers have long been available.) In this size, frame diameter measures 1.062 in. Resolver can be supplied with Mark 4 Mod 0 electrical characteristics, features temperature stabilization and closed-loop path. Immediate deliveries.—*American Electronic Mfg. Co., Culver City, Calif.*

For more information circle **336** on inquiry card.

Long-life Chopper

New "Type 300" miniature 6.3-v. 400 cps. mechanical modulator is rated for 2,000-hr. life. Contacts are s-p.d-t., 1 ma. for signals from 0.1 mv. to 100 v. Unit operates in ambient temperatures from −65 C. to 100 C., is hermetically sealed for humid atmospheres and altitudes to 50,000 ft., withstands 100-*G* shocks.—*Airpax Products Co., Middle River, Baltimore 20, Md.*



For more information circle **337** on inquiry card.

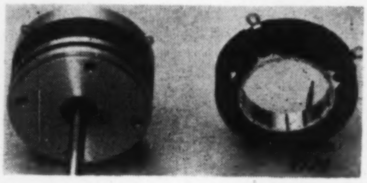
Magnetic Clutch

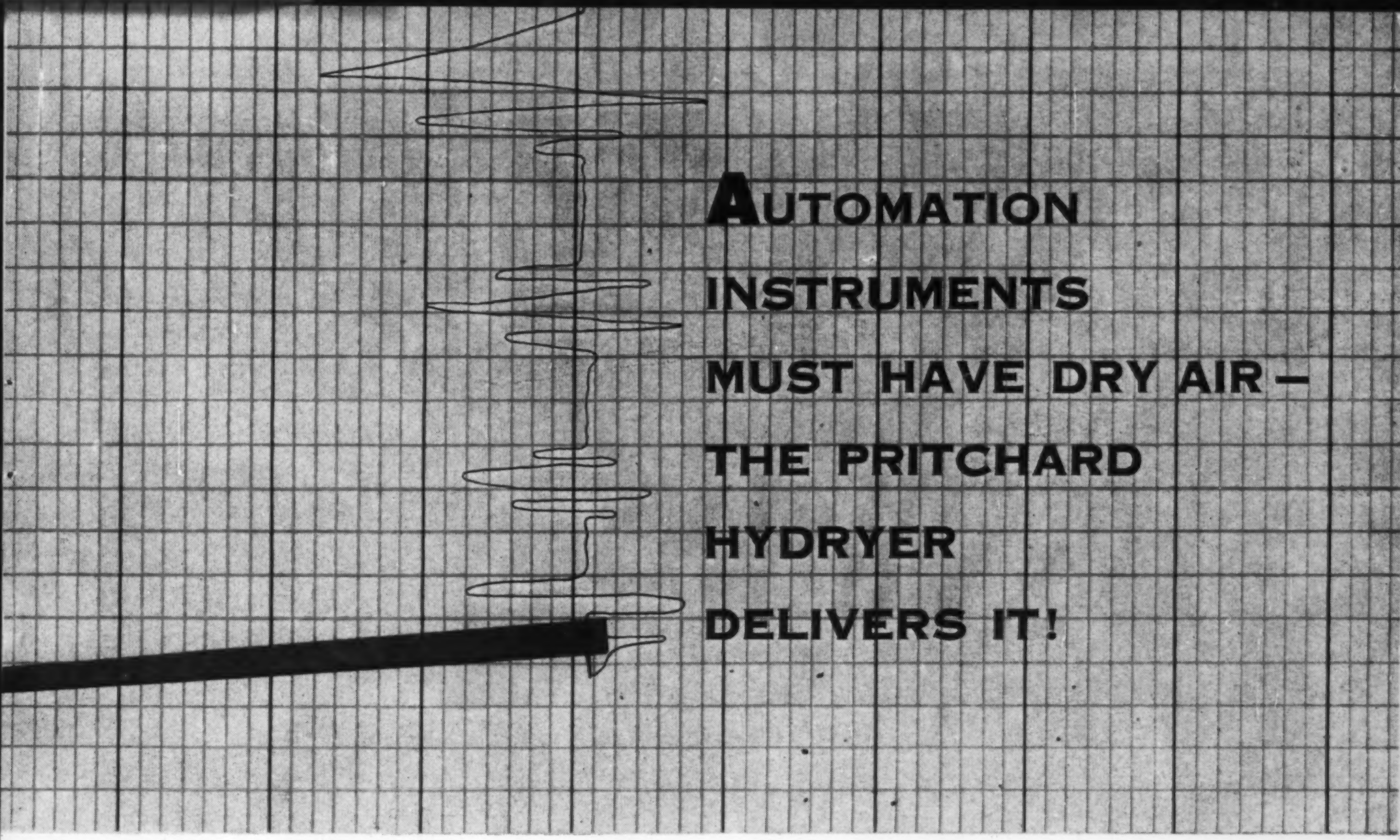
New "Model T508" is a precision electromechanical component designed for servo system applications requiring the possibility of engagement or disengagement of either one or both output shafts from a single input shaft. Functions of shafts may be reversed so that outputs can be used as inputs. Mounting is identical to MK 8 Mod O servo motor.—*Sterling Precision Instrument Corp., Instrument Div., 34-17 Lawrence St., Flushing 54, N. Y.*

For more information circle **338** on inquiry card.

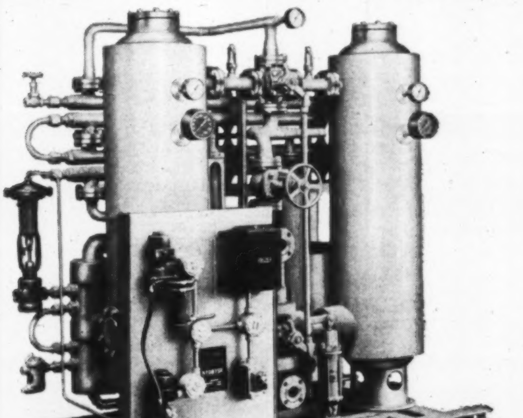
Commutator-Generator

New "Precision Commutator and Impulse Generator," for high-speed switching, counting, pulse gating, etc., comprises a series of conducting segments insulated from one another and





AUTOMATION INSTRUMENTS MUST HAVE DRY AIR — THE PRITCHARD HYDRYER DELIVERS IT!



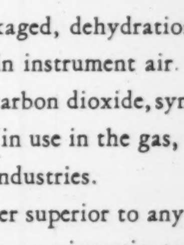
Precision instruments depend upon a constant source of exceptionally dry air to operate accurately. Instrument and plant shutdowns due to moisture, corrosion, icing are too expensive to be tolerated in the modern plant.

The Pritchard Hydryer®—a low-cost, packaged, dehydration unit—ends the possibility of moisture formation in instrument air.

The Hydryer removes moisture from air, carbon dioxide, synthesis gas and many other gases. It has been proved in use in the gas, chemical, petroleum, electric utility and general industries.

Exclusive design features make the Hydryer superior to any other such unit on the market today. Why don't you investigate these features?

WRITE TODAY for HYDRYER BULLETIN 16.0.081 on your company letterhead!



INDUSTRY'S PARTNER FOR PROGRESS

COOLING TOWERS
GAS & AIR TREATING EQUIPMENT

REPRESENTATIVES IN PRINCIPAL CITIES FROM COAST TO COAST

J.F. Pritchard & Co.
OF CALIFORNIA
A DIVISION OF J. F. PRITCHARD & CO.
Dept. 449 4625 Roanoke Parkway, Kansas City 12, Mo.

For more information circle **72** on inquiry card.

A SIX-TANK PORTABLE EXPLOSION PROOF UNIT FOR
TESTING FUEL
CONTROLS OF
JET ENGINES

ONE
OF
SIX
UNITS DESIGNED & BUILT FOR
GREER HYDRAULICS INC.

- **Completely explosion proof. No electricity used. Cooling by dry ice, heating by steam (mechanical if required).**
- **Temperature range: —85°F; —40°F; —10°F; +20°F; +164°F; +200°F. Each tank capable of controlling temperature within a 60°F range.**
- **Pneumatic control system capable of controlling temperature in baths to ±1°F or better.**
- **All circulating pumps and agitators driven by air motors.**
- **Compact, portable unit; overall exterior dimensions only 36" x 34" x 48" high to table top. Tank dimensions 5" x 7" x 12" deep.**

Built and designed by experts in all types of environmental test equipment, International Radiant Corp., the above testing unit is solving the testing problems of the Greer Hydraulics Corp. IRC has the engineers and facilities to solve any problem in Environmental Testing — Altitude — Vacuum — Sand and Dust — Salt Spray — Fungus — Humidity — 'Hot and Cold' — Mobile Refrigeration — in any combination or combinations to suit your needs The above illustrated unit is only one of the very many IRC units being used throughout Industry.

Our Engineering staff will be happy to discuss and quote on your Testing requirements at no obligation to you. We also have Representatives in leading cities.

WRITE FOR OUR
NEW 1955
CATALOG NA-6-G

INTERNATIONAL RADIANT CORP.
MEMBERS, ENVIRONMENTAL EQUIPMENT INSTITUTE
4 MANHASSET AVENUE, PORT WASHINGTON, NEW YORK

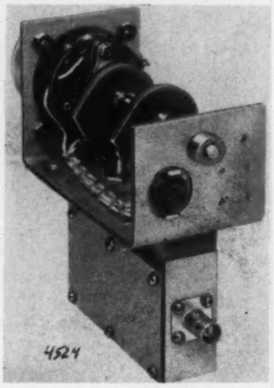
For more information circle **73** on inquiry card.

interconnected to form a wide variety of coded commutation or pulse sequences. Speeds up to 1000 rpm.; life in excess of one million revolutions.—*Computer Instruments Corp.*, 1964 *Utica Ave., Brooklyn* 34, *N. Y.*

For more information circle **339** on inquiry card.

Remote-control Attenuator

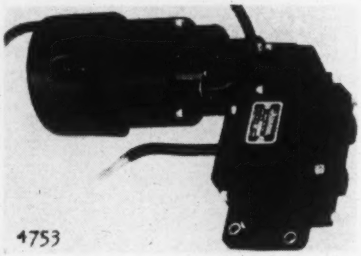
New "Series 544" unit is a new remote-control adaptation of standard R-F attenuator, is cam-operated and solenoid-driven. Features include a special arm which permits remote selection of several cam-operated positions on the attenuator. Is flat from dc to 225 megacycles, and maintains a resistance accuracy to ± 2 percent. Power rating is 0.25 watt. Operates on 115 v dc.—*Daven Co.*, 191 *Central Ave., Newark, N. J.*



For more information circle **340** on inquiry card.

Power Unit

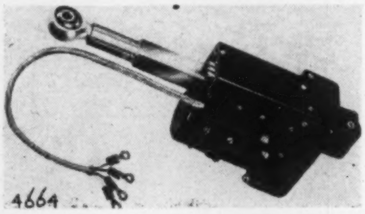
New "Model 474" bidirectional 2-speed gear-driven drive unit is instantly reversible without reversal of motor armature; develops output torque of 44 lb.-in.; employs two hysteresis type magnetic clutches for torque independent of speed.—*American Electric Motors Inc.*, 4811 *Telegraph Rd., Los Angeles* 22, *Calif.*



For more information circle **341** on inquiry card.

Power Unit

New "Type ACT-3090 Linear Actuator" weighs 1.4 lb., said to be 25 percent less than actuators of comparable performance. All major dimensions are also reduced by 25 percent. Rate may be changed from 1.6 to 30 in./min. in convenient steps. Maximum end play is less than 0.0018 in., owing to an Acme screw held to "much closer tolerances than specified by any standards known today."—*John Oster Mfg. Co., Avionic Div.*, 1 *Main St., Racine, Wis.*



For more information circle **342** on inquiry card.

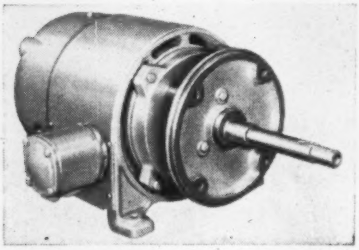
Reversible Motor

New instantly-reversible 1725-rpm. fractional-horsepower motor especially designed for use on door operators, machine tools, cranes and hoists has a five-stud terminal board with reversing connection diagram on inside of terminal box cover for quick installation. Sizes ¼, ⅓, ½ and ¾ hp.; 115 or 230 v. ac.,—*General Electric Co., Schenectady* 5, *N. Y.*

For more information circle **343** on inquiry card.

Pump Motors

New 1½ to 25 hp. totally-enclosed and explosion-proof close-coupled pump motors are for use with centrifugal pumps operating in dangerous, damp or dusty locations.—*U. S. Electrical Motors, Inc., Box* 2058 *Terminal Annex, Los Angeles* 54, *Calif.*



For more information circle **344** on inquiry card.

Miniature Toggle Switch

New "Model A3-8" features new patented spring mechanism for smooth operation and positive snap-action in either direction. Spring mechanism is made of berylium copper. Two miniature basic switches, encased in actuator, provide a double-pole, double-throw circuit arrangement.—*Electro-Snap Switch & Mfg. Co.*, 4218-20 *W. Lake St., Chicago* 24, *Ill.*

For more information circle **345** on inquiry card.

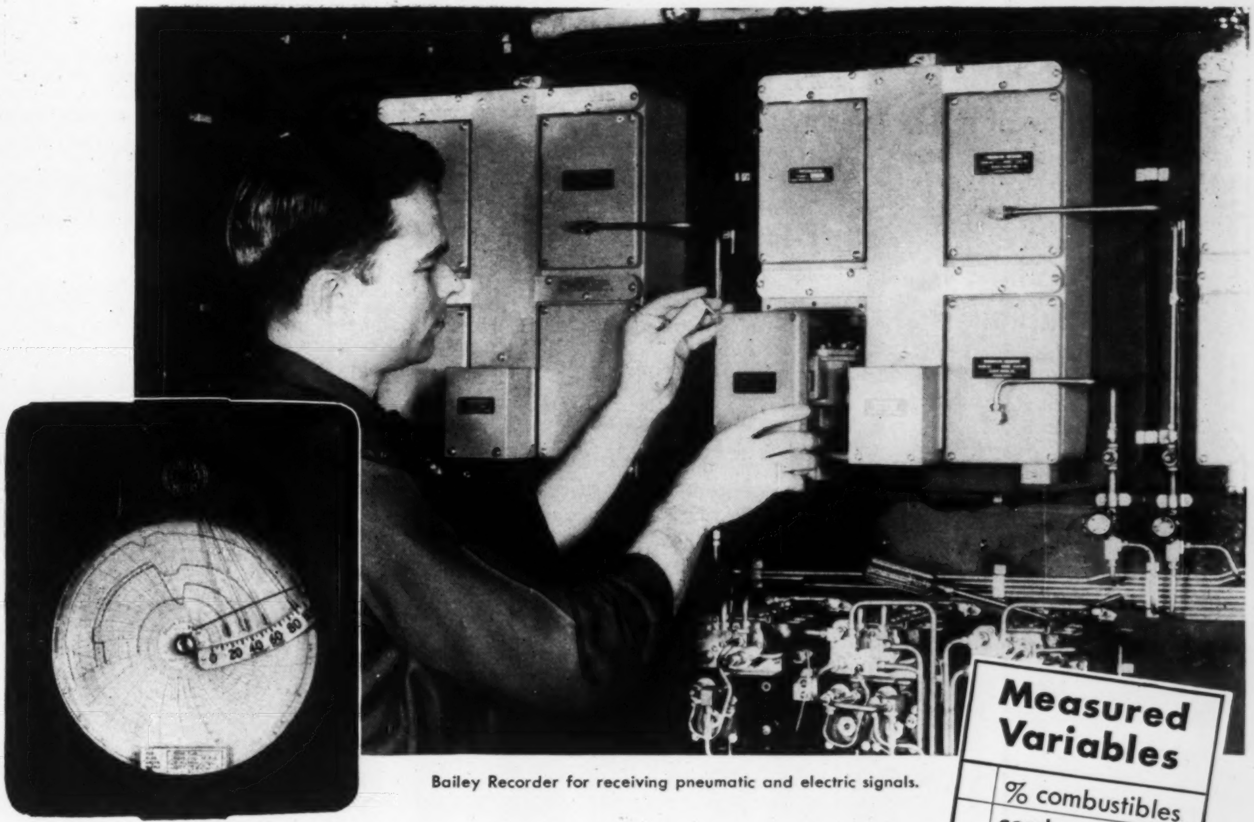
Custom Stack Switches

New stack switch assemblies consisting of a pile-up of various springs, insulators, etc., are available in innumerable different arrangements. All assemblies made to individual requirements. Among items varied to meet customer needs are: spring length, thickness and material; spacers; contacts; tubing; lifters or pushers; leaf indicators; brackets; cam followers (two roller bracket designs, nickel-plated brass and other materials of various diameters); mounting hardware.—*Switchcraft, Inc.*, 1328 *N. Halsted St., Chicago* 22, *Ill.*

For more information circle **346** on inquiry card.

Arm-actuated Switch

New "Rotary Actuator," claimed to be "the first of its kind on the market," features roller actuator arm with op-



Bailey Recorder for receiving pneumatic and electric signals.

Pick any four, plug in, and record

Measured Variables

- % combustibles
- combustion
- conductivity
- density
- differential
- draft
- flow
- liquid level
- % oxygen
- pH
- position
- pressure
- ratio
- smoke density
- specific gravity
- speed
- temperature
- vacuum

Here is a receiver recorder, custom-built *by you* to meet your needs, no matter how changeable, how complex. On a single chart you can record any four measured variables—and interchangeable receivers permit new combinations almost at will.

Individual plug-in pneumatic or electronic receivers—and corresponding integrators—are interchangeable in the four identical frame slots. You can select any combination; even including two receivers and their two integrators.

Think what this can mean to you! Parts inventories are minimized; re-use of components keeps instrumentation costs economically low when cycle changes are frequent—and you can even tie in with your existing transmitters.

Ask for Product Specification E12-5.

P33-1

★

ONLY BAILEY OFFERS ALL THESE ADVANTAGES IN A SINGLE RECORDER

- Pre-calibrated plug-in receiver units
- Up to four pneumatic or electronic receivers —or two receivers and two integrators
- Any four variables on one chart—easily read and interpreted
- A full year's ink supply at one loading
- Faster ordering—from stock
- Minimum inventory of parts
- Minimum instrument investment for process cycle expansion or alteration

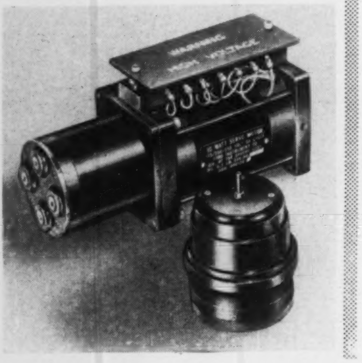
BAILEY
METER COMPANY
1041 IVANHOE ROAD
CLEVELAND 10, OHIO

Controls for Power and Process

Controls for
TEMPERATURE
PRESSURE
GAS ANALYSIS
FLOW · LEVEL
RATIO · DENSITY

For more information circle **74** on inquiry card.

PRECISION
A-C Rate Generators
and
single-shaft servo packages
from FORD INSTRUMENT



- offered in 60cy and 400cy models
- available temperature compensated for wide ambient range
- extremely stable, linear units with high voltage output

Ford Instrument's a-c rate generators are designed for any use which requires a high degree of accuracy in the linear translation of rotational motion into voltage. They are especially valuable in servo systems to stabilize responses, and can be provided in convenient single-shaft packages with a wide variety of precision servo motors.

FREE — fully illustrated data bulletin gives specifications and performance information. Please address Dept. IA

59

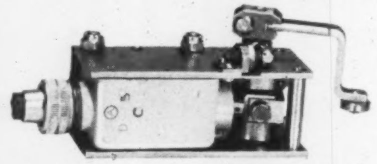
FORD INSTRUMENT COMPANY
Division of The Sperry Corporation
31-10 Thomson Ave.
Long Island City 1, N. Y.

Ford Instrument's standard components

Rate Generators	Differentials	Servo Motors
Telesyn Resolvers	Integrators	Telesyn Synchros

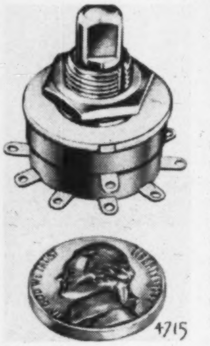
For more information circle **75** on inquiry card.

tional settings throughout 360 degrees and operating travel of 90 degrees; also basic switch using same type of sealing principle as larger aircraft models. Actuating force of 20 lbs. assures positive operation and "breakthrough" of any ice formations on switch.—*Electro-Snap Switch & Mfg. Co.*, 4218 *W. Lake St., Chicago* 24, *Ill.*



For more information circle **347** on inquiry card.

Single-deck Switch

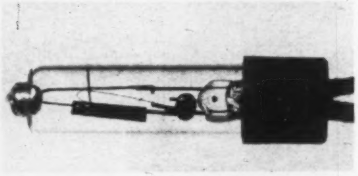

4715

New "24YY2100" single-deck switch incorporating positive detent has been added to "Series 24" miniature tap switches; features reduction of back-of-panel depth of single deck to 0.562 in. and over-all diam. across terminals of 1.032 in. Rated to break 1 amp. 115 v.ac., it will carry 5 amps. if not required to make or break circuit. Maximum of ten positions available.—*Grayhill*, 561 *Hillgrove Ave., La Grange, Illinois.*

For more information circle **348** on inquiry card.

Mercury Switch

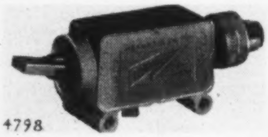
New hermetically-sealed magnetically-actuated mercury switch features improved mechanical stability. Armature and movable contacts are supported by conductive bearing; spring is used for return only. No leads to flex; no organic components. Contacts are moved magnetically in or out of mercury up to 60 times/sec. Rating 0.5 amp. 115 v.ac. or 0.25 amp. dc.—*Hamlin, Inc.*, 1316 *Sherman Ave., Evanston, Ill.*



For more information circle **349** on inquiry card.

Ice-proof Switch

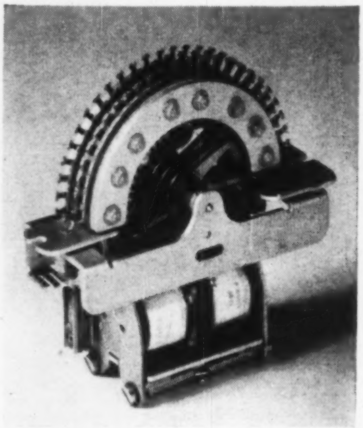
New design of hermetically-sealed aircraft switch features ability to reset even when coated with ice. Available actuators include roller, leaf, cam and many others. Rating: 10 amps. for 125/250 v.a.c, 28 v.d.c, inductive and 28 v.d.c, resistive.—*Electro-Snap Switch & Mfg. Co.*, 4218 *W. Lake St., Chicago* 24, *Ill.*


4798

For more information circle **350** on inquiry card.

Stepping Selector Switch

New two-way stepping selector, designed for control and indication circuits, operates in either direction at a speed of approximately 65 steps per second on self-interruption, and at speeds up to 20 steps per second from external impulses.—*Imtra Corp.*, 58 *Charles St., Cambridge, Mass.*



For more information circle **351** on inquiry card.

Binding Post

New "Series 29 Multi-Purpose Binding Post" can be mounted on ¾ in. centers, or less if desired; on panels up to 3/16 in. thick. Metal parts are brass, cadmium-plated to withstand 50-hr. minimum salt spray exposure. —*Grayhill*, 561 *Hillgrove Ave., La-Grange, Illinois.*

4640

For more information circle **352** on inquiry card.

MECHANICAL COMPONENTS

Differential

New miniature differential gear unit (for use as a computing element) is of hollow-shaft type. Models are available for either ⅛- or 3/16-inch shaft. Backlash is less than 7 minutes; backlash of 3 minutes is available on special order. Breakaway torque is less than 0.01 oz.-in.—*Reeves Instrument Corp.*, 215 *E. 91st St., New York* 28, *N. Y.*

For more information circle **353** on inquiry card.

Differential

New "Model T750" precision differential does not have usual two input shafts at opposite ends of spider;

low-cost "work horse"

for heavy duty jobs

Automatic Electric Class "A" Relays are still "healthy" even after 100,000,000 operations!

Here's a relay built for hard work, and every critical point shows it!

Contact points are formed and life-welded to the spring in one operation. An exclusive armature backstop design prevents armature freezing. A heavy-duty armature bearing is available for unusually heavy spring loads, or constant high-speed use.

Optional "long" or "short" lever armatures offer one lever-ratio for normal operating speeds . . . another for slow-to-release action, providing a residual gap which holds the required release timing, even under heavy-duty conditions. When extreme conditions suggest added precaution, an armature damper spring may also be supplied to eliminate wear from induced vibration.

For complete details, write for Circular 1800. Automatic Electric Sales Corporation, 1033 West Van Buren Street, Chicago 7, Illinois. In Canada: Automatic Electric Sales (Canada) Ltd., Toronto. *Offices in principal cities.*

RELAYS PRODUCTS OF THE INDUSTRIAL DEPARTMENT OF **SWITCHES**

AUTOMATIC ELECTRIC

CHICAGO

Dimensions

Overall length, 4"—Width, single pile-up 1¼"—double pile-up 1⁷⁄₁₆"—Height (depending upon the number of springs), Series AQA and ASO 1⅝"; Series ASR and ASA 1⅝"-2".

Four different types

Of Class "A" Relays are available to meet your needs: Series AQA—Quick-Acting, DC; Series ASO—Slow-Operating, DC; Series ASR—Slow-Releasing, DC; and Series ASA—Slow-Acting, DC.

Contacts

Normally single, but can be supplied with twin contacts. Load carrying capacity, 150 watts (maximum 3 amps., non-inductive).

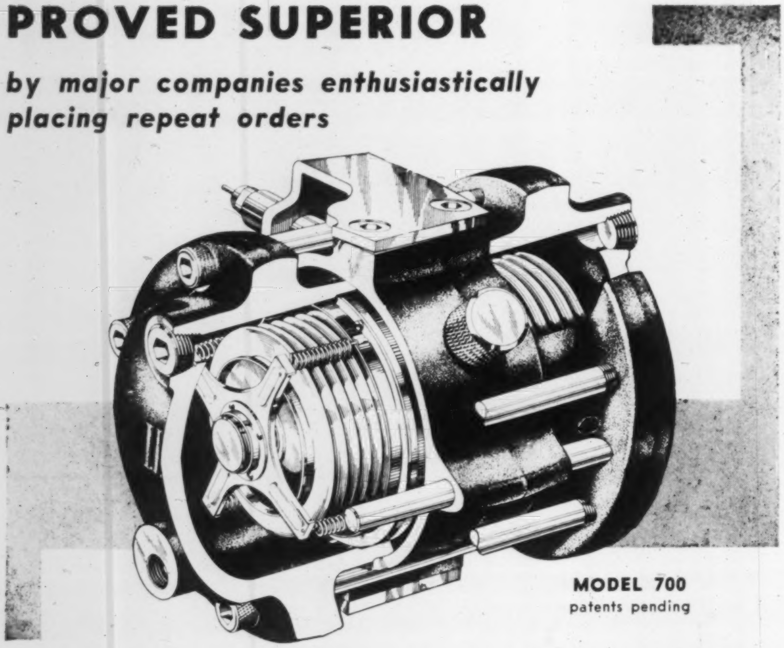
Contact spring capacity

Can be supplied with single or double pile-ups. Series AQA and ASO, 13 springs per pile-up; Series ASR and ASA, 6 springs per pile-up. (More contacts can be accommodated at a sacrifice of operating speed and release time delay.)

For more information circle **76** on inquiry card.

PROVED SUPERIOR

by major companies enthusiastically placing repeat orders



MODEL 700
patents pending

Major companies throughout the world have tried the I. I. C. bellows-type flow meter. In their own exhaustive tests they have found it far superior in performance and construction.

The I. I. C. flow meter is a combination of the most modern engineering features:

Seamless bellows—choice of either type 316 stainless steel or Monel.

Exclusive free-floating, non-freezing bearing designed and engineered by I. I. C.

Forged housings—either alloy steel or 316 stainless.

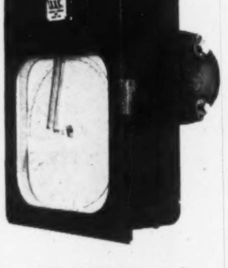
More powerful, this meter gives quicker response and more accurate recording. Pulsation dampener is externally adjustable under pressure. Compensation is provided for ambient temperatures. Affords over-range protection up to housing rating. Working pressures 1,000, 2,500, 5,000 p.s.i., furnished in all standard ranges up to 500 inches of water.

Make your own comparison tests. YOU be the judge.

For full information—including the name of your nearest representative, write for Bulletin 56-B-2—today!

I.I.C. Model 700-MT
Transmitter
(Patents Pending)

Model 800-6
Indicator
(Patents Pending)



Model 802 Recorder
(Patents Pending)

INDUSTRIAL INSTRUMENT CORP.

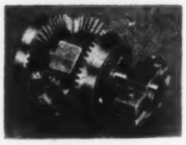
DRAWER 152 ODESSA, TEXAS

For more information circle 77 on inquiry card.

output and both input shafts extend concentrically from one end of a servo-mounted case. Precision bearings result in low break-away torques with minimum backlash.—*Sterling Precision Instrument Corp.*, 34-17 *Lawrence St.*, *Flushing* 54, *N. Y.*

For more information circle **354** on inquiry card.

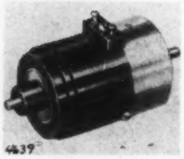
Hollow Shaft Differential



New "Model T700" is a precise differential for high-speed rotation, minimum backlash, and low break-away torque. Shaft lock provides for easy removal of the differential from a gear train without disassembly of end plates.—*Sterling Precision Instrument Corp., Instrument Div.*, 34-17 *Lawrence St., Flushing* 54, *N. Y.*

For more information circle **355** on inquiry card.

Clutch

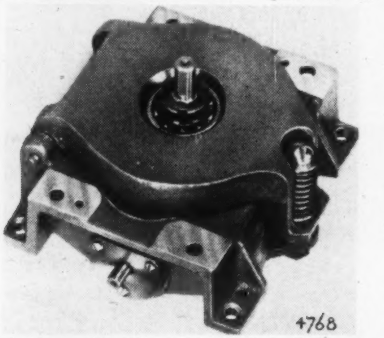


New miniature clutches or clutch brakes operate on principle of electro-magnetic actuation of a friction plate to provide virtually instantaneous starts and stops. Response speed is in milliseconds (depends on application). Energizing coil engages clutch and provides instantaneous power pickup. When coil is de-energized, clutch is disengaged and braking action occurs.—*Globe Industries, Inc.*, 1784 *Stanley Ave.*, *Dayton* 4, *Ohio.*

For more information circle **356** on inquiry card.

Mechanical Integrator

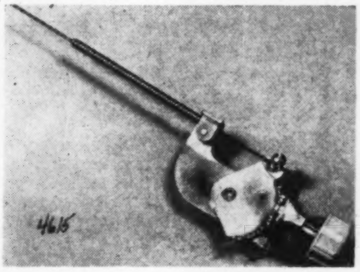
New "Ball and Disc Integrator" originally designed for use in computers and gunfire control systems in solution of differential equations, is well adapted for use in high-performance closed-loop servo systems; is also an accurate variable-speed drive. Total ball carriage travel 2 in. Integrator error (in percent of total local value) is less than 0.1 percent over most of ball carriage range under typical disc-speed and output-torque conditions.—*Instrument Components Div., Belock Instrument Corp.*, 14-34 112*th St., College Point, N. Y.*



For more information circle **357** on inquiry card.

Flexible Shaft Control

New sector gear and pinion device, together with wire-type flexible control produces 1½-inch of linear push-pull motion by turning the knob 270 degrees.—*Arens Controls, Inc.*, 2017 *Greenleaf St., Evanston, Ill.*



For more information circle **358** on inquiry card.

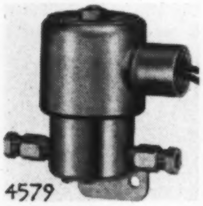
VALVES

Solenoid Valve

New "Bulletin 8030A" direct-lift solenoid-operated packless valve, designed for low-pressure application (to 7 psi.) is available in ⅜-in. and ½-in. pipe sizes; is said to be ideally suited for low-pressure air and gas control on gas-fired ovens and furnaces, etc.; is normally closed; requires 10 watts to operate.—*Automatic Switch Co., Orange, N. J.*

For more information circle **359** on inquiry card.

Noiseless Solenoid Valve



New electropneumatic switch features quiet operation. When energized, it passes full air at supply pressures up to 25 psi. When deenergized, supply port is stopped and return line pressure is vented to atmosphere. Manual adjustment permits valve opening when coil is deenergized. Coils can be supplied for 115, 208, 230, or 440 v.ac.—*Dep't IAP, The Powers Regulator Co., Skokie, Ill.*

For more information circle **360** on inquiry card.

Solenoid Valves

New "Type K" piston-pilot solenoid valves feature all-stainless-steel construction of parts in contact with media; "Velvetrol" cushioned closing; full port openings; operation over a wide pressure range. Standard equipment includes Teflon renewable discs and Guidon pilot valve seats which

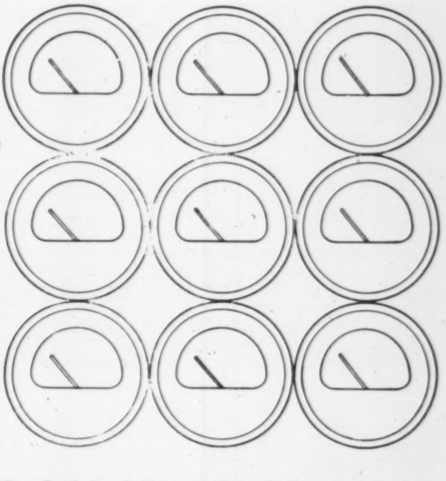
precision instruments by DeJUR

There's "big meter" precision in this Series 100 **SEALED SUBMINIATURE METER**

ACTUAL SIZE

Now you can specify this tiny, light weight instrument and still get ±3% accuracy over full scale. Special "O" ring and locknut provide watertight, single hole mounting. Complete technical literature sent on request.

9 Meters in Only 3¾" Square!



DeJUR

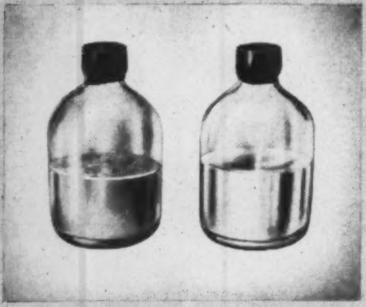
DeJUR Sealed and Ruggedized Instruments: 1", 1½", 2½" and 3½". Send us your requirements and we will submit our quotations.

ELECTRONIC SALES DIVISION • DeJUR-AMSCO CORPORATION
45-01 Northern Blvd., Long Island City 1, New York

"You're always sure with DeJUR instruments."

For more information circle **78** on inquiry card.

ANNOUNCING
the NEW vacumetal mercury...



offering the highest standard of purity ever achieved for mercury metal... at no extra cost!

★

Free of any apparent meniscus or oxidation . . . ordinarily detectable by the eye . . . this new mercury is ideally suited for laboratory use and for use in the manufacture of delicate electrical, electronic and other sensitive instruments with automation, computer, or general applications.

For further information on this new vacumetal mercury, write to:

Samples shown in illustration were shipped from coast to coast to proof test the superior quality of the vacumetal mercury shown on the right.

A sample for your own evaluation may be secured at nominal cost.

METALSALTS CORPORATION | 200 WAGARAW ROAD HAWTHORNE, N. J.

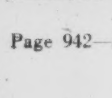
For more information circle 79 on inquiry card.

These PILOT LIGHTS *give you* 180° VISIBILITY for the most effective indication *plus* BUILT-IN RESISTORS (*a patented Dialco feature*) for operation on 105-125V. or 210-250V.

The required **RESISTOR** is an integral part of the unit — **BUILT IN** (Pat. No. 2,421,321). Also, simple external resistors for all higher voltages.

Every assembly is available complete with lamp.

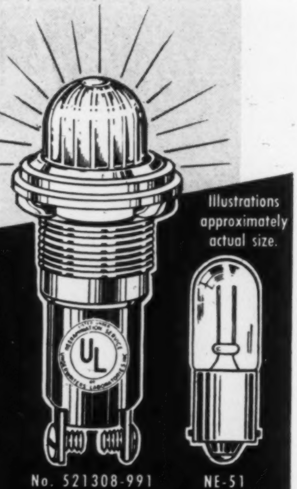
SAMPLES ON REQUEST AT ONCE — NO CHARGE



FREE Brochure on "Selection and Application of Pilot Lights"

Also write for our latest Catalogues.

DIALCO



Illustrations approximately actual size.

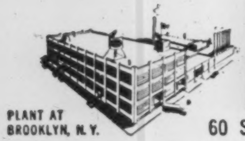
No. 521308-991

NE-51

For NEON Lamps

Choice of fluted or clear caps; binding screws or soldering terminals.

Available for both 9/16" and 11/16" mounting clearance holes.



PLANT AT BROOKLYN, N.Y.

Foremost Manufacturer of Pilot Lights
DIALIGHT CORPORATION

60 STEWART AVE., BROOKLYN 37, N. Y. • HYACINTH 7-7600

For more information circle 80 on inquiry card.

aid tight seating. Coils are unconditionally guaranteed. Explosion-proof coil housings and many special assemblies are available.—*J. D. Gould Co., 730 E. Washington St., Indianapolis 2, Ind.*

For more information circle **361** on inquiry card.

Solenoid Valves for SMs

New "dry-solenoid" valves are proportional-type electrically-commanded four-way valves for 1000 to 3000 psi., featuring isolation of torque motor from hydraulic fluid, so that entrained iron or other agents cannot impair torque-motor operation. Operating principle gives high dynamic response, sensitivity and linearity. Available units have max. output flows from 0.1 to 50 gpm. for rated control currents between 2.0 and 40.0 ma. Primary application: high-performance electrohydraulic servomechanisms (valve input from a balanced push-pull d-c. amplifier). Loop natural frequencies of 95 cps. can be obtained for an unloaded servo with an uncompensated amplifier, result being a servo having high response and minimal static error.—*Moog Valve Co., East Aurora, N. Y.*

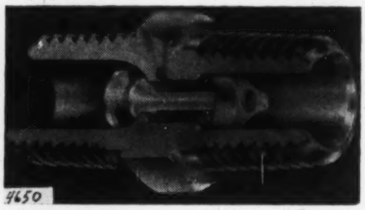
SERVO VALVE
MOOG VALVE CO. INC.

4852

For more information circle **362** on inquiry card.

Check Valve

New "2300 Series" is a low cost valve for 0-10000-psi. range. Floating poppet design is not affected by foreign particles in fluid and eliminates "wire drawing" across seat. Suitable for most high-pressure hydraulic or pneumatic applications. Available in several materials.—*James-Pond-Clark, 2181 E. Foothill Blvd., Pasadena 8, Calif.*



4650

For more information circle **363** on inquiry card.

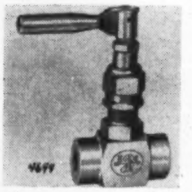
Reducing Valves

New "No. 700" reducing valve is now available in sizes from ½ through 4 in. for initial pressures up to 300 psi, and for delivery pressures from 10 to 75 psi. Offers silent, dead end service, and is especially suitable for supplying low or medium water pressure to buildings from high-pressure city water mains. Features: large flow passages, rugged construction, constant pressure over a wide range of capacity.—*Klipfel Valves, Inc., Hamilton, Ohio.*

For more information circle **364** on inquiry card.

Toggle Valves

New series of quick-acting bar-stock toggle valves, in sizes from ⅛ to ½ inch and with operating pressures up to 1000 psi., feature hardened steel cams to provide a valve-seat closing action tight enough for high-vacuum service. Adjustable cap nut allows for tight seating closure when operating lever is at right angles to stem. Another adjustment permits lever to travel in any desired plan parallel with stem. Direct panel mounting is possible without modification.—*Hoke, Inc., 231 S. Dean St., Englewood, N. J.*

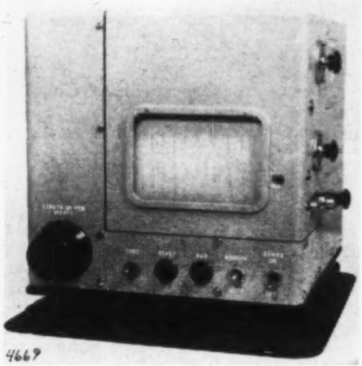


For more information circle **365** on inquiry card.

MISCELLANEOUS

210-channel Recorder

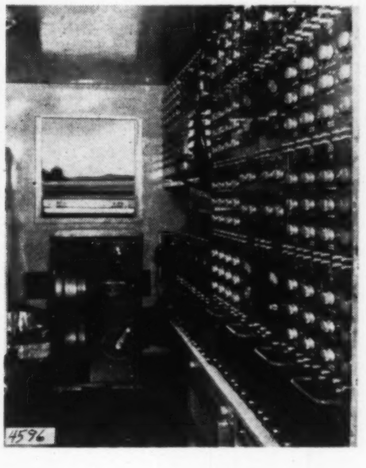
New "R-1021-D" recorder is a 210-channel fixed-stylus recorder, writing on a 5-inch-width electrosensitive chart. Designed for airborne and ground applications. Accuracy is unaffected by temperature, humidity, and vibration.—*Radiation, Inc., Melbourne, Fla.*



For more information circle **366** on inquiry card.

Magnetic Seismic Recorder

New "MagneDISC" system permits recording an unprecedented amount of seismic information. Use of flat, cir-



EPIC

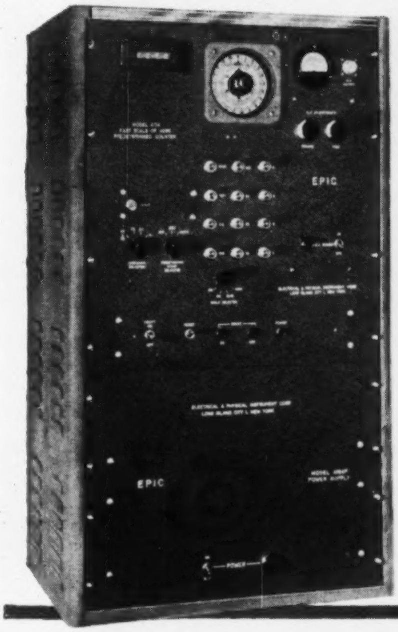
EPIC FAST PULSE AND COUNTING EQUIPMENT

10 MC SCALERS
(Model 4000 Series)

available with:

- Predetermined count
- Predetermined time
- Regulated 500-2.5kv high voltage power supply
- Automatic reset
- Decade or binary systems
- Scale of 1000 or 4096
- 0.1 microsecond resolution
- Preamplifiers and pulse height discriminators

A wide range of choice makes it possible to select the exact high-speed counting equipment desired, from the basic manual models to the most fully automatic and complex counting systems.



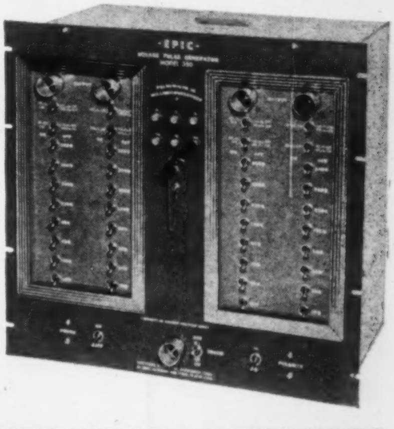
MILLIMICROSECOND
Square Pulse Generators
with single or multiple pulse-outputs: ▶

Rise Time: .001 μsec. from 10% to 90% amplitude.

Pulse Width: .001 μsec. to several μsec.

Pulse Amplitude: From 100 volts to .006 volts in one db steps.

Output Imp: Matched to any impedance for standard coax lines. Multi impedance outputs also available.



ELECTRICAL & PHYSICAL INSTRUMENT CORP.
LONG ISLAND CITY, NEW YORK
EPIC
POWER

WIDE BAND AMPLIFIERS
(Model 700 Series)

Band Width: 2000 cycles to above 10 MC

Gain: 40 db or 60 db (Higher Gains Also Available)

Gain Control: Coarse and Fine Gain Controls Permit a Continuous Gain Variation by a Factor of 100 on Some Models.

Output Limit Level: To 50 Volts for Positive Pulses on Some Models.

Input: Positive or Negative Pulses, or Sine Wave

Discriminator: 0-50 Volt Positive Amplitude Discriminator for Fast Pulses Also Available.

PULSE GENERATORS • 0-10MC COUNTING SYSTEMS • PLUG-IN COUNTING SYSTEMS • 0.1 MICROSECOND RESOLUTION COUNTER CHRONOGRAPHS

ALSO CUSTOM DESIGNED EQUIPMENT TO MEET YOUR INDIVIDUAL REQUIREMENTS!

Write for detailed engineering bulletin No. 1002

EPIC **ELECTRICAL & PHYSICAL INSTRUMENT**
CORPORATION
42-19 27th Street, Long Island City 1, N. Y.

For more information circle **81** on inquiry card.

The "darkroom" you carry with you . . . !

Consolidated Type 23-109
OSCILLOGRAM PROCESSOR

Use it anywhere . . . it needs neither water connections nor darkroom . . . automatically delivers a developed, dried oscillogram to you in mere minutes. The hundreds now in use are saving processing time . . . are reducing that vital gap between the test and data availability.

You needn't have great numbers of oscillograph records to justify a CEC processor. Because it will take the entire contents of an oscillograph magazine, it's equally valuable for test programs consisting only of occasional, long-duration runs. Extremely simple, it can be operated even by inexperienced personnel.

- *portable, automatic*
- *250-ft. record capacity*
- *thermostatic control*
- *rapid . . . up to 15 fpm*

Write for Bulletin
CEC 1537B-X3.

Consolidated Engineering *Corporation*
ELECTRONIC INSTRUMENTS FOR MEASUREMENT AND CONTROL
300 North Sierra Madre Villa, Pasadena 15, California
Sales and Service Offices Located in: Albuquerque, Atlanta, Buffalo, Chicago, Dallas, Detroit, New York, Pasadena, Philadelphia, Seattle, Washington, D. C.

For more information circle **82** on inquiry card.

RELAYS

ALLIED • LEACH • GUARDIAN
MINIATURE AIRCRAFT
TELEPHONE TYPE and many others

SENSITROLS

STEPPING SWITCHES

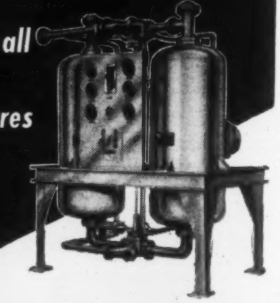
SEND FOR OUR LATEST BULLETINS AND ADD YOUR NAME TO OUR MAILING LIST
cable address: UNIGENCOR, N. Y.

324 CANAL ST. (Near B'way) N. Y.—WA 5-9642
Universal general corp.

For more information circle **83** on inquiry card.

The Instrument Air Dryer

with all the features



- ★ **Exclusive Finned System Desiccant Chambers**
- ★ **Automatic, Semi-Automatic, or Manual Control**
- ★ **Compact Functional Design (ASME Code)**
- ★ **Safety Interlock Control System**
- ★ **Atmospheric and Pressure Regeneration Circuits**
- ★ **Moisture Indicator and Instruments Panel Mounted**
- ★ **Superior Desiccant**
- ★ **Exit Dewpoint below minus 40°F at line pressure**
- ★ **Steam and Electric Reactivation**

Submit your Dryer problems to our experienced instrument engineers.

SEND FOR Illustrated Bulletin

3170

Industrol CORPORATION
494 Westfield Avenue, East • Roselle Park, New Jersey

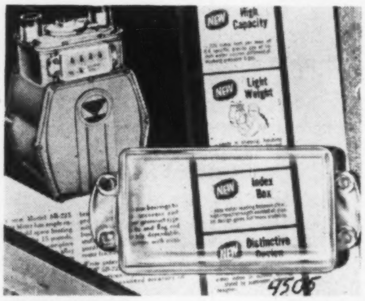
For more information circle **84** on inquiry card.

cular magnetic disc makes possible recording up to 96 data channels on one easy-to-load plastic disc; because recording is done in one complete revolution of disc (5½ seconds), shot may be fired at any time. Discs are changed by pushing "eject" button. Disc records can easily be safely stored.—*Houston Technical Labs, 2424 Branard, Houston 6, Texas.*

For more information circle **367** on inquiry card.

Meter Index Box

New "Plexiglass Index Box" is molded in one piece of impact and shock resistant plastic. Is suitable for exterior and interior setting of gas meters, also simplifies work of meter readers.—*American Meter Co., 1513 Race St., Phila., Pa.*



For more information circle **368** on inquiry card.

Gyroscope

New "CG100" gyroscope is an electrically driven amount gyroscope designed to control attitude of aircraft or guided missiles where vibration and steady state accelerations are moderate to heavy; separate synchro pickoffs are provided for each axis. Caging mechanism orients gimbals with respect to mounting surface.—*Automatic Controls Div., Clary Multiplier Corp., San Gabriel, Calif.*

For more information circle **369** on inquiry card.

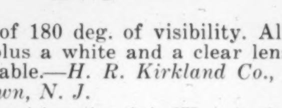
Vertical Gyro

New "Series 2153" vertical gyro, designed to reduce and stabilize free drift error, is vertical reference for gyro-stabilized equipment. Eliminates variations in free drift with changes in operating temperatures, heretofore a major deficiency of operational gyros. Features: subminiaturized slip-rings and brushes, self-aligning bearing suspensions, and shielded rotor and gimbal bearings.—*Lear, Inc., 110 Ionia, N.W., Grand Rapids 2, Mich.*

For more information circle **370** on inquiry card.

Indicating Lamp

New "T2 SLC-P Unit" has lens cap of plastic: shows brilliantly when bulb is lighted, providing well in excess of 180 deg. of visibility. All colors plus a white and a clear lens are available.—*H. R. Kirkland Co., Morristown, N. J.*



For more information circle **371** on inquiry card.

Air Filtering Device

New "Model F-1 Air Filter" is for air in pneumatically-operated apparatus. Filtering element is a phenolic resin-impregnated cellulose cylinder capable of removing dirt particles as small as 40 microns on standard models (smaller on special order). Cleaning of filter element is quickly accomplished by washing in solvent.—*Conoflow Corp.*, 2100 *Arch St.*, *Philadelphia* 3, *Pa.*

For more information circle **372** on inquiry card.

Air Filter Gage

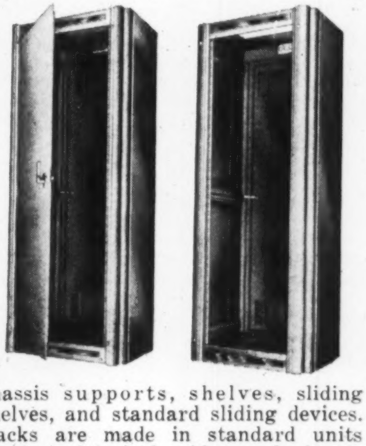
New "Air Filter Gauge" for ventilating and air conditioning systems provides continuous monitoring of dust-removal efficiency of air filters. When pressure differential across filter due to dirt accumulation becomes excessive, signal vane flips up into view. Built-in electric switch can operate a signal light or alarm.—*Bacharach Industrial Instrument Co.*, 7301 *Penn Ave.*, *Pittsburgh* 8, *Pa.*

FILTER GAUGE
RENEW
FILTER

For more information circle **373** on inquiry card.

Cabinet Racks

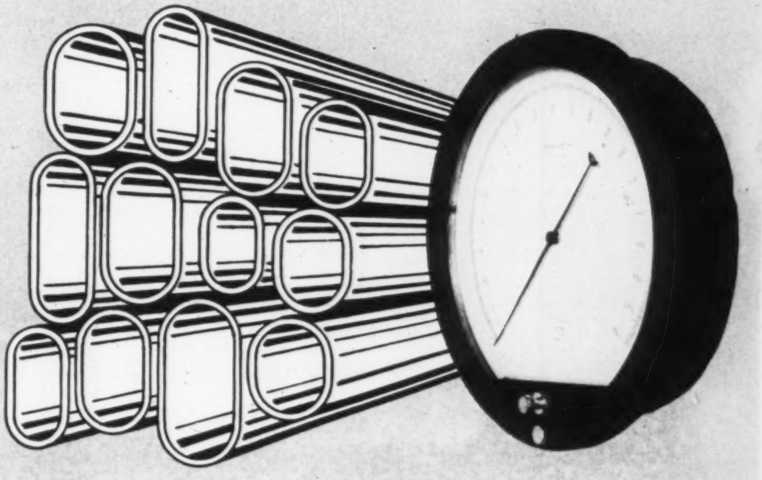
New "Par-Metal" line of completely assembled racks includes universal type with provisions for mounting chassis supports, shelves, sliding shelves, and standard sliding devices. Racks are made in standard units of 19- and 24-inch wide panels, in 18-



HEISE GAUGES

Designed for Dependability

Does your high pressure gauge application require a scientifically designed Bourdon Tube?



Where highly accurate results are required design considerations such as the depth — width ratio of the Bourdon Tube section are of paramount importance.

Extreme fiber stress resulting from improper design of the tube may render an apparently good instrument completely undependable.

At the Heise Laboratories, mathematical solutions for determining the size and shape of Bourdon Tubes for specific use are augmented by years of research and tests on various types of tubes to assure correct stress distribution.

Heise Bourdon Tubes are heat treated by scientific methods to guarantee that each tube will be metallurgically sound for its application. The precision heat treatment of thin walled tubing without distortion has been made possible by equipment and technique developed by Heise Laboratories.

Catalog on Request

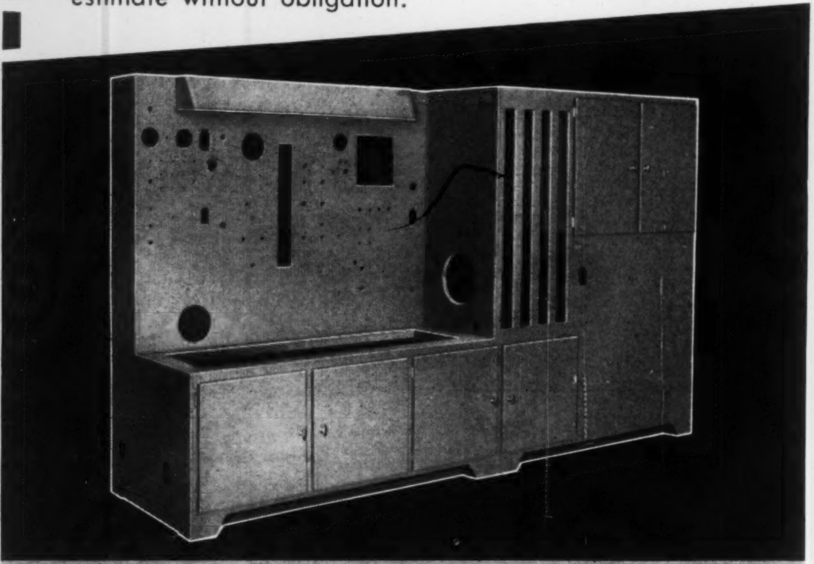
Pressure Ranges 15 to 20,000 P.S.I. Dial Sizes 8½"—12"—16"

Prices from $151.60. **DELIVERY WITHIN 30 DAYS.**

HEISE BOURDON TUBE COMPANY, INC.
BROOK ROAD, NEWTOWN, CONNECTICUT, U.S.A.

For more information circle **85** on inquiry card.

Is size, accuracy, delivery or price *your* problem? Then be sure to have Littleford fabricate your cabinet, cubicle or control panel. Mail us your blueprint for prompt estimate without obligation.



Fabricators of plate and sheet metal products for industry since 1882

LITTLEFORD

LITTLEFORD BROS., INC.
404 E. Pearl St., Cincinnati 2, Ohio

For more information circle **86** on inquiry card.

WE CARRY IN STOCK ALL SIZES, ALL SHAPES, ALL ALNICO GRADES

When you need them— as you need them . . .

HIGH ENERGY, PRECISION ALNICO PERMANENT MAGNETS

Experimental or production quantities

24 HOUR DELIVERY

PERMAG

ENGINEERING
PRECISION CUTTING
PRECISION GRINDING
MAGNETIZING

Catalog upon request

PERMAG CORP., 210 TAAFFE PLACE, BROOKLYN 5, N. Y. — Phone: MAin 2-0114

For more information circle **87** on inquiry card.

The Last Word In Books

Nuclear Reactors for Industry and Universities, edited by Ernest H. Wakefield, 1954, cloth, 102 pages, 4-page index. Price $2.00 ☐

A Bibliographical Survey of Flow Through Orifices and Parallel-Throated Nozzles by T. H. Redding, 1952, cloth, 207 pages. Price $6.00 ☐

Electronic Circuitry for Instruments and Equipment by Milton H. Aronson, 1953, cloth, 310 pages. Price $4.00 ☐

Process Control by A. J. Young, 1954, 140 pages, 3-page index. Price $2.00 ☐

payment must accompany order

Instruments Publishing Company
845 Ridge Avenue
Pittsburgh 12, Pennsylvania

Enclosed is $.............. **for**...............**copies**

of ....

Name ....

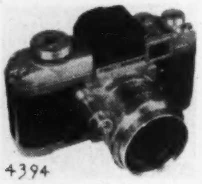
Address ....

City ....

and 24-inch depths, and in standard heights.—*Par-Metal Products Corp., 32-62 49 St., Long Island City 3, N. Y.*

For more information circle **374** on inquiry card.

50-mm. Camera



4394

New "Schneider ALPA Xenon" 50-mm.f/1.9 features "completely perfected automatic diaphragm." Automatic mechanism may be disconnected; allows groundglass "through-the-lens" focusing at full aperture, for pictures taken at any stop from f/1.9 down to f/16.—*Karl Heitz, Inc.,* 150 *W. 54th St., New York* 19, *N. Y.*

For more information circle **375** on inquiry card.

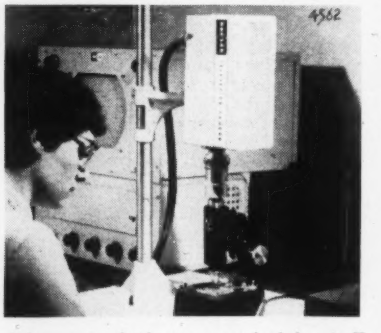
Chilling Machine

New "XA 120-2" 2-cubic-foot low-temperature chilling machine has clear opening of 21½ x 10½ inches. Chilling chamber size is 24 x 12 x 12 inches. At minus 120 deg F with convection fluid, machine has capacity of 300 BTU's per hour. Standard accessories include a 500-watt heater to convert machine for high and low temperature testing in range from –120 deg to +200 deg F.—*Cincinnati Sub-Zero Products,* 3930 *Reading Rd., Cincinnati* 29, *Ohio.*

For more information circle **376** on inquiry card.

Microscope Stand for TV

New microscope stand on which maker's closed-circuit television camera is mounted vertically permits microscope image to be presented on a large TV screen for a large group of students or industrial observers; minimizing eye fatigue; maximizing efficiency of production operations in which a large number of miniature precision parts are being examined continually.—*Kay Lab,* 5727 *Kearny Villa Rd., San Diego, Calif.*



For more information circle **377** on inquiry card.

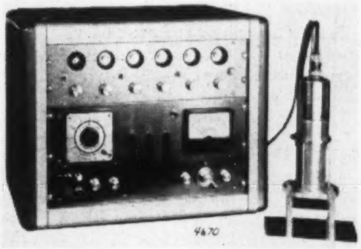
Shielded Wire

New cable features close semi-conducting textile wrap and a stranded flexible drain wire instead of conventional braided copper shield. Conductors are cadmium copper for improved flex life and insulated with rubber. Cable is not subject to damage by twisting and by pressure of heavy equipment running over it. Available in 2- and 3-conductor cables.—*Whitney Blake Co., New Haven* 14, *Conn.*

For more information circle **378** on inquiry card.

Glow-transfer Register

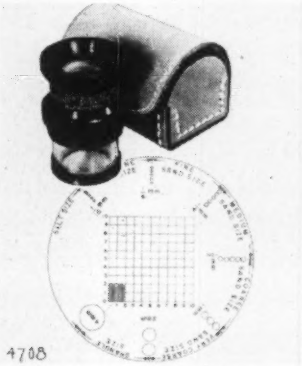
New "GT-6" glow-transfer register, for use with "Model 200" scaler, permits preselection of any count from 10 to a million. Scaler will stop at exact number it is set for, without under- or over-shoot.—*Radiation Instrument Development Lab., 2337 W. 67 St., Chicago 36, Ill.*



For more information circle **379** on inquiry card.

Sand-measuring Magnifier

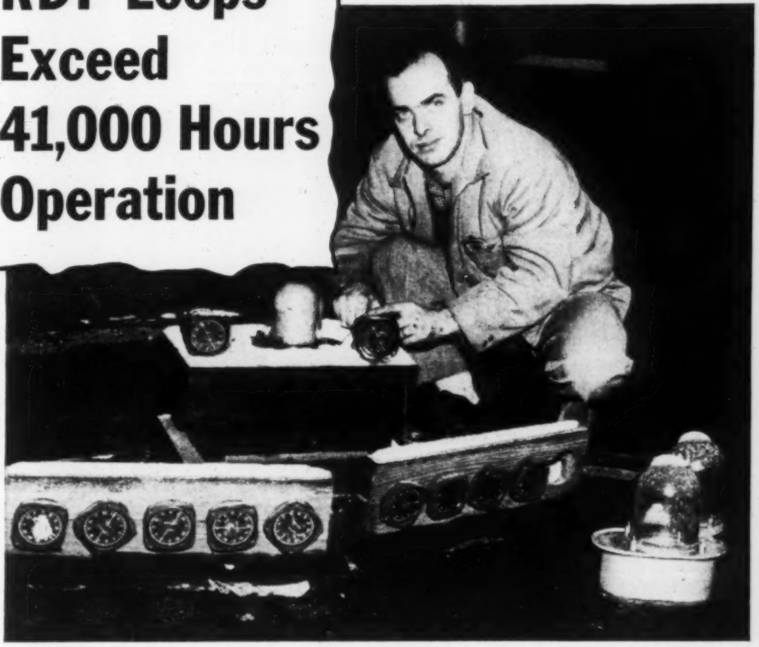
New geological instrument makes it possible to analyze specimens on spots from which taken. Etched glass reticle is superposed directly on specimen. Reticle pattern shows upper and lower limits of various grain sizes; grid scale facilitates counting particles per unit area. Instrument can be used as a magnifier alone. A battery-powered illuminator is available.—*Edmund Scientific Corp., Barrington 3, N. J.*



For more information circle **380** on inquiry card.

Optical Elements

New lenses, prisms, optical flats and windows, as well as complete optical sub-assemblies, previously made for armed forces, are commercially available. Announcement adds that high-vacuum coating department is among largest and most modern in U. S. Among materials evaporated



Kearfott RDF Loops Exceed 41,000 Hours Operation

Test Made with Equipment Exposed to Full Range of Weather Conditions.

The Kearfott AS-313 Radio Direction Finder Loop and the ID-90 Indicators withstood continuous operation for 41,977 hours. This is over 40 times the 1,000 hours required by Air Force specifications for Sealed Aircraft instruments.

The ability of Kearfott equipment to operate long beyond requirements is significant. The same hermetic seal principle employed in the construction of Kearfott Loops is also used to impart dependability and long life to Kearfott Gyros, Computers and Packaged Servo Systems.

The Kearfott organization is available to you to aid in meeting instrumentation requirements of modern airborne equipment.

—Send for Technical Data Sheets

KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components. Send for bulletin giving data of components of interest to you.

ENGINEERS:

Many opportunities in the above fields are open. Please write for details today.

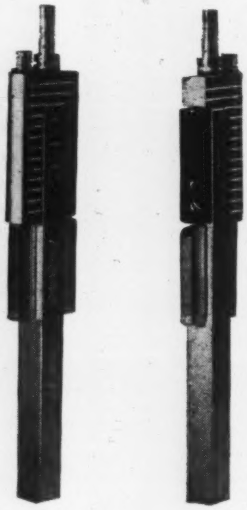
Kearfott

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.

Sales and Engineering Offices: 1378 Main Avenue, Clifton, N. J.
Midwest Office: 188 W. Randolph Street, Chicago, Ill. South Central Office: 6115 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

For more information circle **88** on inquiry card.



Most efficient galvanometers ever made

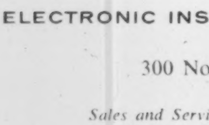
Higher frequency response without sacrifice of sensitivity . . . higher sensitivity without loss of frequency response. *Both* needs are answered by a group of *high-performance* galvanometers being added to CEC's 7-300 Series. The first three of the group are outlined below. For the same frequency range, *sensitivity is quadrupled* . . . and a completely new field of low-output strain-gage applications is opened.

All new models have the same construction, are completely interchangeable with others in the 7-300 Series . . . *world's most widely used recording galvanometer.*

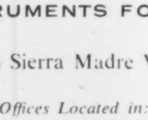
	GALVANOMETER TYPE NUMBER		
	7-342	7-345	7-346
Frequency Range (cps)	0-135	0-200	0-190
Natural Frequency (cps)	225	335	320
*Sensitivity (µa/in)**	10.8	24.3	27.2
Source Impedance (for .64 damping)	350	180	350
Coil Resistance	83	79	52
*Standard Balance (in/g)**	.008	.008	.008

*at standard 11.5" optical arm

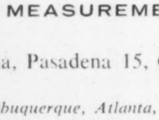
For complete specifications, write for Bulletin CEC 1559-X2.



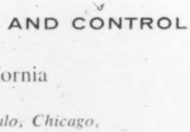
TYPE 5-114



TYPE 5-116



TYPE 5-117



TYPE 5-119

THE NEW HIGH-PERFORMANCE GALVANOMETERS MAY BE USED IN ANY OF THESE CEC OSCILLOGRAPHS.

Consolidated Engineering
Corporation

ELECTRONIC INSTRUMENTS FOR MEASUREMENT AND CONTROL

300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service Offices Located in: Albuquerque, Atlanta, Buffalo, Chicago, Dallas, Detroit, New York, Pasadena, Philadelphia, Seattle, Washington, D. C.

For more information circle **89** on inquiry card.

are magnesium fluoride, aluminum, silver, and gold. Dichroic coatings and vignetted coatings produced to specs. —*Zenith Optical Laboratory, Copiague, L. I., N. Y.*

For more information circle **381** on inquiry card.

Transistorized Power-line Carrier

New transistorized power line carrier, first to be placed in commercial production, is a narrow-band frequency-shift apparatus utilizing transistors to achieve maximal continuity of service with mimimal maintenance and up to 75 percent reduction in power consumption. Unique heterodyne transmitter and superheterodyne receiver provide transmission of high-speed information at the same close channel spacing of 500 cps. throughout 40-to-200-kc. band. Three types of information can be transmitted: opening and closing of a single contact; position of s-p. d-t. center-neutral contact (as used for raise-neutral-lower load control); and alternating frequencies up to 100 per second. Keyed functions can be transmitted at the rate of 60 pulses per second.—*Motorola Communications and Electronics Inc.*, 4501 *W. Augusta Blvd., Chicago* 51, *Ill.*

For more information circle **382** on inquiry card.

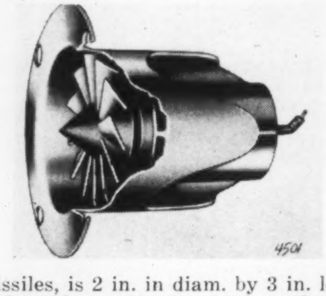
Photocopy Machine

New "Dial-A-Matic Auto-Stat" takes guess work out of making copies. Setting dial to match type of original automatically produces a sharp, dry copy in 30 seconds.—*American Photocopy Equipment Co.*, 1920 *W. Peterson Ave., Chicago* 26, *Ill.*

For more information circle **383** on inquiry card.

Axial Flow Blower

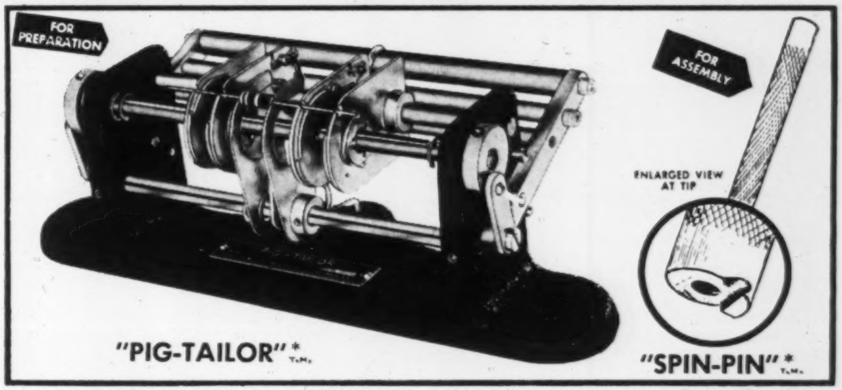
New axial flow blower, developed for high-speed aircraft and guided missiles, is 2 in. in diam. by 3 in. long and produces 60 cfm. at less than 1 amp. Blower motor is powered by either d.c. or 440-cycle a.c.—*Air Equipment Co.*, 2248 *E.* 37 *St., Los Angeles, Calif.*



For more information circle **384** on inquiry card.

"PIG-TAILORING"

. . . . a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.



The "PIG-TAILOR" plus "SPIN-PIN" — Accurately Measures, Cuts, Bends, Ejects and Assembles both leads simultaneously to individual lengths and shapes — 3 minute set-up — No accessories — Foot operated — 1 hour training time.

PIG-TAILORING provides:

1. Uniform component position.
2. Uniform marking exposure.
3. Miniaturization spacing control.
4. "S" leads for terminals.
5. "U" leads for printed circuits.
6. Individual cut and bend lengths.
7. Better time/rate analysis.
8. Closer cost control.
9. Invaluable labor saving.
10. Immediate cost recovery.

PIG-TAILORING eliminates:

1. Diagonal cutters.
2. Long-nose pliers.
3. Operator judgment.
4. 90% operator training time.
5. Broken components.
6. Broken leads.
7. Short circuits from clippings.
8. 65% chassis handling.
9. Excessive lead tautness.
10. Haphazard assembly methods.

* PATENT PENDING

Write for illustrated, descriptive text on "PIG-TAILORING" to Dept. IA6-P

BRUNO-NEW YORK INDUSTRIES CORPORATION
DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT
460 WEST 34th STREET • NEW YORK 1, N. Y.

For more information circle 90 on inquiry card.

Test Your I. Q. (Instrument Quotient)

See Page 1008 for Answers

All Questions are based on editorial matter in this issue.

Question 1

In the Univac Scientific Computer the basic magnetic-tape handler is the

(a) Unityper
(b) Uniservo
(c) Univac
(d) Uniprinter

Question 2

In the Univac Scientific Computer of Remington Rand, the artithmetic operations are performed in the

(a) X Register and magnetic drum
(b) Q Register and Accumulator
(c) Magnetic-core Memory
(d) Uniservos

Question 3

In the Univac Scientific Computer the term Radix Conversion refers to

(a) converting a vector product to a scalar product
(b) converting decimal to binary numbers, or vice versa
(c) computing a function by linear smoothing
(d) all the above

Question 4

The equation for a closed-loop controlled system is a differential equation whose order depends on the number of capacities in the system. Each capacity raises the order of the equation by

(a) 0
(b) 1
(c) 2
(d) 3

Question 5

The coefficients in the differential equation for a closed-loop controlled system containing resistance and capacitance (lag) terms are

(a) R terms only
(b) RC terms only
(c) RC and R terms only
(d) RC, R, and C terms only

Question 6

A fractionating column requires a relief valve because

(a) overhead vapor line might be blocked
(b) reflux might be lost
(c) pressure control instruments might fail
(d) all the above might happen

Question 7

Heat exchangers require relief valves on the cold-liquid side only

(a) when cold lines might be blocked
(b) if hot lines are unprotected
(c) if hot lines are protected
(d) when connected to other units

Question 8

Turbines and pumps require relief valves on exhaust side because

(a) pressure is higher at exhaust than at inlet
(b) of possibility of blocked outlet lines
(c) of possibility of blocked inlet lines
(d) all the above might be true

Question 9

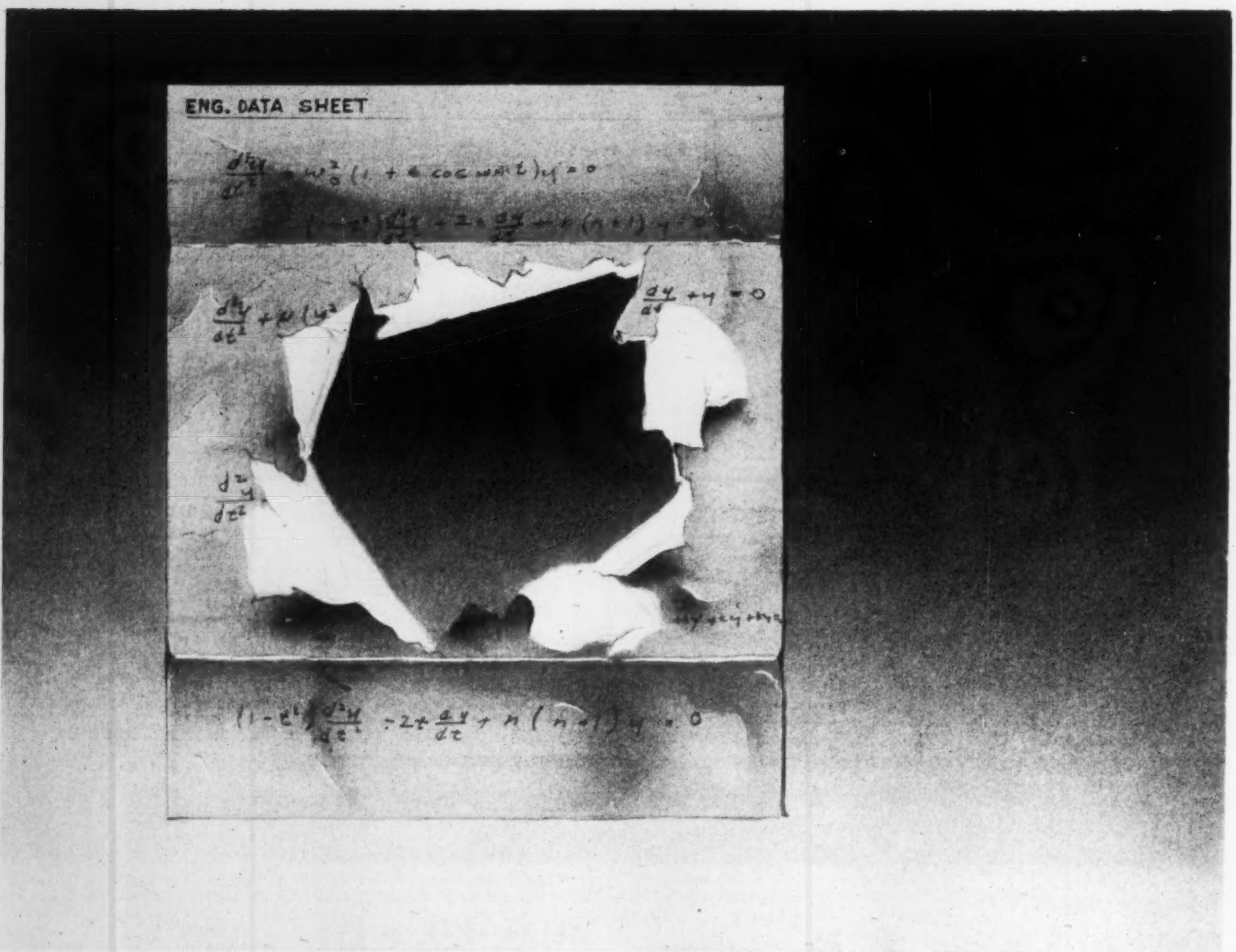
Air preheat in a soaking-pit installation is desirable because of

(a) 30-percent increase in production for all types and grades of steel
(b) decreased installation costs
(c) decreased fuel consumption
(d) all the above

Question 10

Total power generating capacity of the United States in 1955 is about

(a) 1 million kw.
(b) 10 million kw.
(c) 100 million kw.
(d) 1 billion kw.



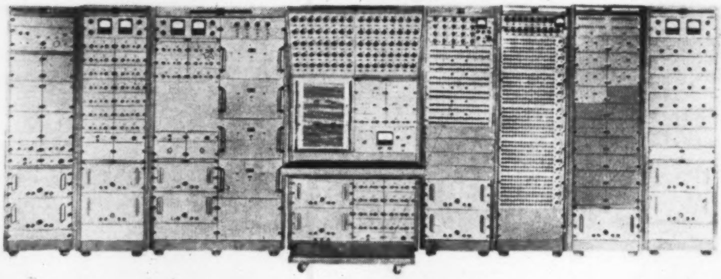
Break Through The PROBLEM Barrier

More and more engineers depend on Electronic Associates' Precision Analog Computing Equipment to break the problem barrier. In these systems they find an unparalleled accuracy, reliability and flexibility—proved by thousands of operational hours.

A unique building-block method permits simplified and economical expansion of the system by addition of standard component groups that can be assembled to meet exact problem requirements, now or in the future.

To familiarize industry with its equipment, EAI maintains a complete Computation Center at Princeton, N. J., for either demonstration or rental on a time basis.

Detailed information on request, including the new line of high-speed servos, problem checks, high-accuracy electronic multipliers, function generators and precision output equipments. Write Dept. IA-8.



Expanded 16-31R System

ELECTRONIC
ASSOCIATES
Incorporated

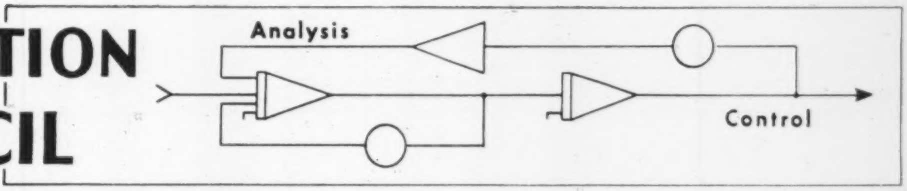
EAI SETS THE PACE

P PRECISION A ANALOG C COMPUTING E EQUIPMENT

LONG BRANCH, NEW JERSEY

For more information circle 91 on inquiry card.

The SIMULATION COUNCIL *Newsletter*



John H. McLeod, Jr., EDITOR

Suzette McLeod, SECRETARY

Western Simulation Council
Norman L. Irvine, Aerojet-General Corporation, Azusa, Calif.; Chairman, Steering Committee.

Midwestern Simulation Council
L. M. Warshawsky, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio; Chairman, Steering Committee.

Eastern Simulation Council
Harold K. Skramstad, National Bureau of Standards, Washington, D.C.; Chairman, Steering Committee.

Bits

This month the feature of the *Newsletter* is Ro Favreau's story of the Eastern Simulation Council meeting at RCA-Princeton. The problem discussed, "Patch Panels and Programming of Analog Computers," is one which confronts all of us who operate analog computers, particularly in the larger installations. There are many solutions, none of them completely satisfactory. Ro's writeup tells how Electronic Associates, Beckman, DACL (MIT), Goodyear, Mid-Century, RCA, and Reeves have attempted to solve their own particular setup problems.

Pieces

EASTERN SIMULATION COUNCIL MEETING

(of 25 March 1955)

by R. R. Favreau

"Patch Panels and Programming of Analog Computers" was the topic for discussion at the last bi-monthly meeting of the Eastern Simulation Council. Host for this meeting, which took place the afternoon of Friday, 25 March, was the David Sarnoff Research Center, RCA Laboratories, in Princeton, New Jersey. Dr. Harold Skramstad (National Bureau of Standards, Washington, D.C.) opened the discussion by asking representatives of various manufacturers to give a brief talk presenting the philosophy and approach to the subject which their company used.

Hamer on EA Equipment

Howard Hamer spoke for Electronic Associates, Inc. (Long Branch, New Jersey), stating that the main factors which guided EA's design of its analog equipment were (1) accuracy, (2) convenience and simplicity of operation, and (3) flexibility.

To maintain accuracy, temperature control and the best available components are used. Computing elements are placed directly behind the patching system so that leads may be kept short. In addition, shielded leads are used to minimize cross-coupling between their amplifiers, which have a wide bandwidth.

A metal patch panel is used to ground the outside conductor of the shielded leads appropriately to force all leakages to ground and to give strength and rigidity.

For convenience and simplicity, it was felt that central control was highly important. Therefore the control of many of the auxiliary racks (amplifiers, multipliers, etc.) was placed directly adjacent to the patch board.

For flexibility, all computing components were grouped into plug-in units which could be located at any position. By this method, setting up or changing a particular system or adding equipment was simplified.

In answer to questions, Howard told Bernie Loveman (Reeves Instrument Corp., 215 E. 91st St., New York 28, N. Y.) that the temperature gradient in the oven is 1 deg. F, maximum; C. Single (Berkeley Scientific Division of Beckman Instruments, 2200 Wright Ave., Richmond, Calif.) that this is achieved by circulating the air within the oven; Louis Bauer (Reeves Instrument Corp.) that the oven runs continuously; C. Murphy (Ballistic Research Laboratories, Aberdeen Proving Ground, Md.) that they have long wires because of using the central control console; and Charlie Morrill (Goodyear Aircraft Corp., Akron 15, Ohio) that 100 deg. F was chosen to be above room temperature and to keep humidity down.

Asked about problems of summing-point capacitance, Howard said that elements such as amplifiers and integrators have been designed to take this into account.

In answer to further questions he told J. Mester (Ballistic Research Laboratories) that it takes somewhat more than an hour to bring all elements up to oven temperature; and Gunther Martin (Schlumberger Instrument Co., Old Quarry Road, Ridgefield, Conn.) that they use a double ground system, one for power and the other for the signal, and that these grounds are tied together at one point. Howard indicated that the exact point is somewhat of a trade secret, and that it must be considered for each individual computer system.

Bauer on "REAC 400"

The Reeves philosophy of patching and programming was presented by

SIMULATION COUNCIL

Dr. Louis Bauer, Head of Project Cyclone. Bauer stated that the new Reeves computer uses a standard patch bay manufactured by Remington-Rand because it is inexpensive and spacing of holes is convenient. However, if all holes were used, the patch cords would be too close together, so they place a mask over the patch panel, leaving visible only those holes which are needed. The resulting pattern allows one to learn the computer by heart in a short time.

To prevent leakage they silkscreen a conducting grid across the entire patch bay and then ground it. One advantage is that when patching while the computer is in operation you cannot accidently short hot leads to ground, as with a metal patch bay.

Another objective of their design philosophy was to make the problem setup foolproof. Therefore all switching has been arranged on the patch bay. Initial-condition potentiometers associated with individual integrators, and ± 100-volt switches associated with potentiometers, have been eliminated. Pots are now patched into the IC terminal of an integrator. The integrating amplifiers can be converted to high-gain amplifiers by connecting a patch cord or plug to a 26-volt terminal which is adjacent to a special terminal associated with the integrator. The switching of all other elements such as servos, etc., also is done at the patch bay with patch cords or plugs. This allows not only all the interconnections but also all the switch positions to be removed and stored when the patch bay is taken off. More intricate connections, like associating amplifiers with resolvers to make polar-to-rectangular conversions, can be made by inserting a single bottle* plug.

The patch panel has an interlock switch which removes all voltages from the patch bay. Therefore, plate voltages can be left on and no warm-up time is required when changing panels.

Louis also described a useful item developed at Project Cyclone—a "dummy plug." This element is placed in the position from which a wire may be removed, later to be replaced. A hole in the back provides a place for the removed wire, and because the plug sticks out from the board it acts as a reminder of the change.

Howard Hamer asked, "While your metallic grids eliminate surface leakage problems, do you run into any difficulty with leakage through the insulating material used for the patch board?" Bauer answered that they have run tests with and without the grid, and with other insulating boards such as those developed by Convair, and found that at 90 deg. F and 90-percent relative humidity, all were bad. The main difference appeared to be the temperature and humidity at which leakage became high. Most of the leakage that did occur was surface leakage, so that the metallic grid was effective. Even with the metallic grid grounded, there was still leakage between terminals, which at low temperatures and low relative humidity was approximately 1,000 kilomegohms.*

Harold Skramstad then asked Charlie Morrill to speak for Goodyear Aircraft, but Charlie was "in poor voice," apparently having talked himself out at the IRE Show.

Hovious on GEDA

Mr. R. L. Hovious of Goodyear's Dynamic Systems and Computation Laboratory came to the rescue, stating that there are two fundamental approaches to analog-computer solutions. One is the mathematical approach where you solve differential equations, and the other is a simulation approach, where computer components are grouped to simulate closely the actual physical system.**

Goodyear feels that the simulation approach is superior because of (1) the economical use of amplifiers, (2) more storage on the problem board, (3) the ability to solve certain problems which are impossible or difficult without the flexibility of changing input and output elements, and (4) better insight into the problem. All the variables of interest can be observed, rather than just the end-point variables.

Mr. Hovious then used a brochure, "Patching and Programming of the Goodyear Electronic Differential Analyzer (GEDA)"* to illustrate his main points. To illustrate the economical use of amplifiers he used a transport delay circuit. When set up with potentiometers and standard amplifiers (fixed input and feedback elements), eight potentiometers and six amplifiers were required. However, when the input and feedback elements could be chosen freely, only four amplifiers and no potentiometers were required.

The desirability of decade resistors to choose inputs over a wide range was illustrated by a circuit which had widely separated natural frequencies. The gains required were obtained by using resistors of 20K and 10 Megs in a single amplifier.

Hovious also used the block-diagram approach to show that this technique is helpful in demonstrating what is going on. He concluded by pointing out that the simulation approach is more advantageous to an engineer than a mathematician.**

Discussion on Hovious' Remarks

C. Single asked, "Do you have any rough figures on the relative cost of a decade resistor as against the fixed resistor and potentiometer?" Answer: "The decade resistor costs about $12. A potentiometer would cost approximately $9, a dial $6, and labor about $18.

Louis Bauer commented that the key to Mr. Hovious' discussion was that both mathematicians and engineers use this type of equipment and that each group will use the equipment differently. With aircraft equations and missile systems you are dealing with equations of motion and it appears easier to solve the equations since no transfer functions are involved.

Mr. E. Massell (Electronic Associates) asked, "Does thinking in terms of inverse coefficients, where you have to calculate the inverse in order to determine the input resistance, slow you up very much?" Hovious answered that it does not take a new man long to get acquainted with the system, but it does slow you up a bit.

Bernie Loveman, speaking in favor of scale-factor pots, felt that it is easier to change a pot setting than to dive into a bunch of patch cords, measure the inverse, and reset a decade.

Hamer: "What kind of stability do you get on a decade resistor?" Answer: We leave it on a bridge for about one minute to be sure of high accuracy.

---

*How about the two-bottle men?

*Not 1 megamegohm?

**Hear! Hear! You *do not* have to be a mathematician to use analog computers for analysis and/or synthesis (i.e., problem solution) by simulation!

*Available, no doubt. Write Charlie Morrill, Goodyear Aircraft Corp., Akron 15, Ohio.

**The ambiguity in this sentence might be deliberate!

David Greenberg (David Taylor Model Basin, Washington, D.C.): "What kind of resistors do you use in a decade?" Answer: Film resistors.

Mr. T. Connolly (Electronic Associates) took exception to the inclusion of both economy and better insight into the problem. He stated that quite often they are mutually exclusive. Usually when you use only one amplifier for a complex transfer function, you do not have things like the first and second derivatives easily available.

Hovious disagreed, pointing out that when transfer functions were built up in this manner they were mostly interested in an input and an output and not in various derivatives within the process. However, flexibility and economy often cannot be achieved at the same time, as in an aircraft simulation where an input and output philosophy do not always apply.

Single warned that you must be careful in this type of circuit because when you change one resistor or capacitor, it may change more than one break point (on the frequency characteristic), or may represent a change of more than one element in an actual filter.

Leonard Pode (David Taylor Model Basin) pointed out that this technique can be used with other computers since many of the important points of the amplifier are available. However, it does not seem to be used extensively, possibly because it takes too much time.

Bernie Loveman stated that a system can be set up in block-diagram form on any computer because various parts of the system can be separated even though it has been described by differential equations.

Jim Follin (Applied Physics Laboratory, Johns Hopkins University, Silver Spring, Maryland) explained that at APL they use both systems, choosing the one that appears most advantageous. For example, they use resistors and capacitors for small time-constants, and integrators for large time-constants.

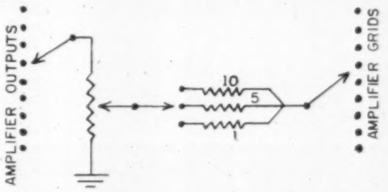
*Single on EASE**

Mr. Single, invited to speak for Beckman Instruments, stated that EASE equipment does not now use a metal patch panel, but that it is under consideration. With their plastic panel they achieve an impedance of about 1 meg meg. They do not use shield connections but rely on the low output impedance of amplifiers for minimum interaction.

Tim Sutton (Mid-Century Instrumatic Corp., New York, N.Y.) excused himself from speaking—the IRE Show must certainly be hard on equipment representatives—and asked Len Pode to describe what Mid-Century has done on a computer for the David Taylor Model Basin.

Pode on David-Taylor Mid-Century

Dr. Pode indicated that his main interest was in the efficiency of the men and not of the computer. He wants to get away from a congested patch board and the requirement of tracing leads. To do this they decided to use a switching system which was built around the potentiometers of the computers. The computer finally decided upon has 20 amplifiers and 30 potentiometers. The switching system is best described by this circuit:



There are two sets of 15 switches, each set to 10 of the 20 amplifiers. With this scheme Dr. Pode indicated that they were able to set up many problems by just setting switches and pots.

Single asked what this did to the summing-point capacitance. Pode replied that it reduced the frequency response somewhat, but not significantly.

Mr. Harris (Reeves Instrument Corp.) then spoke up, saying that his original idea of the Simulation Council was that it would be somewhat of a scientific society with most of the details of equipment being left out. He was surprised to see a letter requesting manufacturers to present their philosophies on patching and programming and a brief description of how this was accomplished by their equipment. He was interested in knowing whether this was what the members wanted.

Dr. Skramstad stated that the letters inviting manufacturers' representatives to this and the next meeting had been sent out in order that specific questions on equipment could be discussed which would be of value to many people. There was no intention to let sales people take over.

Mr. Richmond (Glenn L. Martin Co., Baltimore, Md.) felt that this depended very much upon the subject under discussion at each meeting. If the subject considered equipment in detail, certainly manufacturers could aid materially.

Mr. Struther (RCA, Princeton, New Jersey) suggested that techniques be stressed rather than the company's name.*

Dr. Skramstad summed it up by saying the discussions should be kept on a technical level, but it is desirable also to know what is being developed and what is available from the manufacturers.

Hurney on MIT DACL Equipment

Paul Hurney then presented the views of the Dynamic Analysis and Control Laboratory at the Massachusetts Institute of Technology. Their equipment is of two types—AC and DC—and thus differs from the computers described previously. About 15 standard networks which provide integrators, simple lag circuits, limiting networks, etc., can be plugged into boxes associated with each amplifier. The function of the patch board is routing instead of computing. No computing networks are made up at the patch board.

As more than one problem may be on the machine at one time, a separate patching system is used to tie all the amplifier voltage and mechanical servo overload signals on a problem into a central point. An additional patching system is used to control the various electronic or mechanical units (such as integrators or servos) used on a problem.

The DACL computer has many automatic features. During a precomputing period the initial conditions are applied, the recorders started up, calibration marks placed on both Brush recorders and XY plotters, and the overload system erased. When the problem is started, a start pip is introduced on all recorders. Should an overload occur, an appropriate mark is again made on the recorders. This entire procedure of setting up, running, stopping, and resetting the computer can be programmed either manually or automatically.

---

*Pass possible poignant puns!

* It has always been Simulation Council policy to mention names where they are pertinent, with malice toward none. Reputable manufacturers value the opinion of equipment users. If their product is not held in high esteem by some they of course do not want to advertise it, but if we stick to facts there is nothing they can do but improve their product!

Struther on R C A DSS Philosophy

Mr. Struther, asked to describe the approach RCA has used in designing their prototype model for a proposed large-scale Air Force computer, recognized that the most common method of programming used in large-scale simulators is patch-board programming. This has advantages such as unlimited flexibility of interconnection and the ease of connecting external inputs and recording and measuring devices.

The experience of RCA with Typhoon indicated, on the other hand, that some of the disadvantages of patch-board programming were serious enough to warrant consideration of new methods. Therefore, a card-programming system has been developed for the Dynamic System Synthesizer (the large-scale simulator which RCA proposes to build for the Air Force), and tried on the small prototype which is nearing completion. This system provides problem storage, and permits free programming while the computer is solving other problems. It also eliminates many errors of patch programming. The card programming could be done sequentially by using standard IBM cards. However, the cost precluded complete development of the sequential system, so they turned attention to a parallel semi-automatic method which uses relatively small punched cards with a 20 x 20 matrix. Each card is inserted in a program board and stays in place for the duration of the problem. Desired connections are made by contacts which pass through the cards. A fixed contact in the form of a hollow cylinder, flared out conically at one end, is mounted in the back panel of the problem board. A mating spring-loaded contact, in the form of a cylindrical piston turned down hemispherically at one end, is mounted on the door of the program board. The punched card is attached to the back panel using locating pins and spring clips. When the door is closed the spring-loaded contacts at locations where holes have been punched, pass through the holes and make the desired connection.

At other locations the spring-loaded contacts are restrained by the insulating paper. This paper must have mechanical strength, dimensional stability with changes of temperature and humidity, low conductivity, low dielectric constant, and high resistance to absorption of moisture. At present, 5K1A craft paper, which is a 5-mil-thick insulating paper with an unspecified acetate coating, is used. On the basis of some limited tests this paper seems superior to any other paper which RCA had at the time. After more than five months it appears satisfactory as to leakage, etc., but it has a tendency to shrink. So far this has not been objectionable.

One interesting factor is the force exerted by the array of contacts. Each contact exerts a two-ounce force in its compressed form. For a 50 x 50 array (2500 contacts) the force is about 300 pounds. A specially designed mechanism is required to help get the door closed.

To avoid continual flexing of cables or the use of slip rings, there are no permanent electrical connections in the door. The door connections to the horizontal crossbars are made by a set of standard holes in the punched cards.

Mr. Struther did not have the up-to-date figures on the number of components that will be built into the DSS, but roughly there will be 200 amplifiers, 100 integrators, and 100 multipliers. A computer of this size could require over 3 million switch contacts if a universal crossbar scheme were used in which every point could be connected to every other point. This type of redundancy can be reduced a long way by considering that the typical simulator is essentially a group of simple problems with a moderate number of inter-connections between them. Thus total number of switches required for all uses will be about 65,000.

The programming system for the computer is based on the use of three types of switching panels. The first type programs a section of the problem. The second type selects inputs and outputs for that section, and the third type of panel routes the inputs and outputs to the other sections of the problem.

Two auxiliary types of switch panels are used. One is for programming input and feedback impedance values in a binary fashion. The resistor values start at 62½K and run up to 128 megohms. So you have a maximum resolution in the resistance values of about one part in 2,000, and in the vicinity of one megohm, where a great deal of computation is done, the resolution is about one part in a hundred. The big computer also will be provided with some form of digitally-set pots for use where the resolution given by the binary system is not satisfactory. In addition to setting up input and feedback impedances, this auxiliary switch panel sets up the break points and slopes for the function generators.

The second type of auxiliary switch panel is used for interrupting the interconnecting leads which are not in use at the time, but which are connected to other portions of the computer. This is to reduce the load capacitance on elements which are actually in use.

This system has been applied successfully on paper to several full-scale guided-missile problems without running into limitations due to the method of programming. Its mechanical features and general utility have been tested by solving several dozen problems on the prototype, and few errors have occurred in the translation of simulation block-diagrams to computer programming cards. No problem so far has been encountered which was within the capabilities of the small computer but which exceeded the capabilities of the programming system.

Demonstration

Following this discussion, the meeting was turned over to Mr. Lehmann of the RCA Laboratories. Coffee and doughnuts were served, and RCA's prototype model of the computer was demonstrated.

Information (Without Theory)

We have just received a copy of a paper "Operational Equations for Programming Electronic Analog Computers" by H. M. Martinez, which we heard him present at the Louisiana State University High-Speed Computer Conference this spring. It describes a method for deriving the computer setup for solution of a problem by means of mathematical operators which subsequently provide a convenient and condensed record of the inter-connections made. Hugo claims other advantages for his method, and although it seems to us that it would appeal more to the mathematical than to the engineering-minded, it does have the advantage of eliminating the necessity for diagram, and showing in more detail just how some changes are made. He would probably be happy to send you a copy of this paper, if you address him at Berkeley Scientific Division of Beckman Instruments, 2200 Wright Avenue, Richmond, Calif.

***

We are also fortunate enough to have come into possession of a paper by O. R. Frisch, circa 4955 A.D., on the "Feasibility of Coal-Driven Power Stations." This erudite paper considers the possibility of using a material, believed to consist largely of the black fossilized remains of plants, as an alternative to fissionable material for the production of power. The potentialities are weighed against the problems inherent in the design of a reactor, the optimum configuration of the fuel element and methods of oxidation, the means of control, and—more serious—the health hazards involved. Those concerned about the future of our civilization when our supplies of fissionable material may be exhausted are urged to write us about this paper. If enough interest is shown, permission may be sought to publish the paper in its entirety (about 500 words) in these pages, possibly with the inclusion of a photograph of a crude pilot reaction made possible by the great resources of this scientific publication.

Computer Events

Eastern Simulation Council
Date: Monday, July 11
Place: Naval Air Development Center, Johnsville, Penna.
Subject: Analog Solutions of 3-dimensional problems. Contact: H. G. Tremblay, NADC, Johnsville, Penna.

Midwestern Simulation Council
Date: Monday, 20 June, 1:00 P.M.
Place: Armour Research Foundation, 10 West 35th St., Chicago, Ill.
Subject: "How to Run a Computing Facility". Representatives of WADC, Goodyear, Cyclone, Electronic Associates and Berkeley Scientific will probably speak. Contact: R. E. Zenner, Electrical Engineering Dept., Armour Research Foundation.

Western Simulation Council
Date: Thursday, 14 July, 1:00 P.M.
Place: Naval Ordnance Laboratory, Corona, Calif.
Subject: "Computer Techniques for Optimizing Dynamic Systems II". The first meeting on this subject proved so interesting (and settled so little) that it was decided to continue the subject. Story of the first meeting will be published in July **Instruments and Automation.** Contact: Don R. Totten at NOL.

Midwestern Simulation Council
Date: Monday, 15 August, 1:00 P.M.
Place: Wright Air Development Center, Wright Field, Ohio
Subject: "Cute Tricks in Simulation"—Demonstrations of equipment will be featured. Contact: Dr. L. M. Warshawsky, Attn: WCRRU, c/o Wright-Patterson Air Force Base, Ohio

Summer Engineering Seminar in Automation
Dates: 13-17 June 1955
Place: Pennsylvania State University, University Park, Penna. Sessions will stress the theoretical aspects of planning, instituting, and operating an automation system, along with such problems as economic consequences, equipment design and construction, standardization, scheduling, tooling, and control and integration. Contact: Eric A. Walker, Dean of the College of Engineering and Architecture.

Course in Advanced Servomechanism and Automatic Control Theory
Dates: 27 June—19 August 1955
Place: Department of Electrical Engineering, University of Wisconsin, Madison, Wisconsin. Prime purpose of the course is to advance a critical, integrated account of all that consequential servomechanism theory which now exists in published form **beyond** the range of the basic content encompassed in current text-books on servomechanism theory. Contact: H. A. Peterson, University of Wisconsin.

Special Seminar Program on "Numerical Control of Machine Tools"
Dates: 22 August—2 September 1955
Place: Massachusetts Institute of Technology, Cambridge, Mass.

Association for Computing Machinery
Dates: 14-16 September 1955
Place: University of Pennsylvania, Philadelphia, Penna.
Subject: Annual Meeting. Persons wishing to present papers at this meeting should submit three copies of abstracts of not more than 120 words to the chairman of the Program Committee, Professor J. P. Nash, Digital Computer Laboratory, University of Illinois, Urbana, Ill., by June 15.

International Analog Computation Meeting
Dates: 27 September—1 October 1955
Place: Brussels, Belgium

Advance Registration Announcement
SECOND COMPUTER CLINIC

to be held in conjunction with the Second International Automation Exposition Chicago Navy Pier, Nov. 15-17, 1955.

The Second Computer Clinic offers each registrant a choice of six 2-hour lecture and demonstration classes on analog computers, digital differential analyzers, data processors, and special-purpose computers. A Computer Handbook, containing all 12 presentations, will be given to each registrant.

Sessions will be conducted by the following computer principals:

The Austin Company
Berkeley Div., Beckman Instruments, Inc.
Clevite-Brush Development Co.
Bendix Computer Div., Bendix Aviation
Electronic Associates, Inc.
Goodyear Aircraft Corporation
International Business Machines Corporation
Librascope, Inc.
Four more to be announced.

No registrations from employees of computer manufacturers will be accepted. Registration will be terminated when class facilities are filled. Registration fee is $5.

Second Computer Clinic
Second International Automation Exposition
845 Ridge Ave., Pittsburgh 12, Penna.

Please enter my registration.
☐ Fee is enclosed. ☐ Bill me.

Name ....

Company ....

Title ....

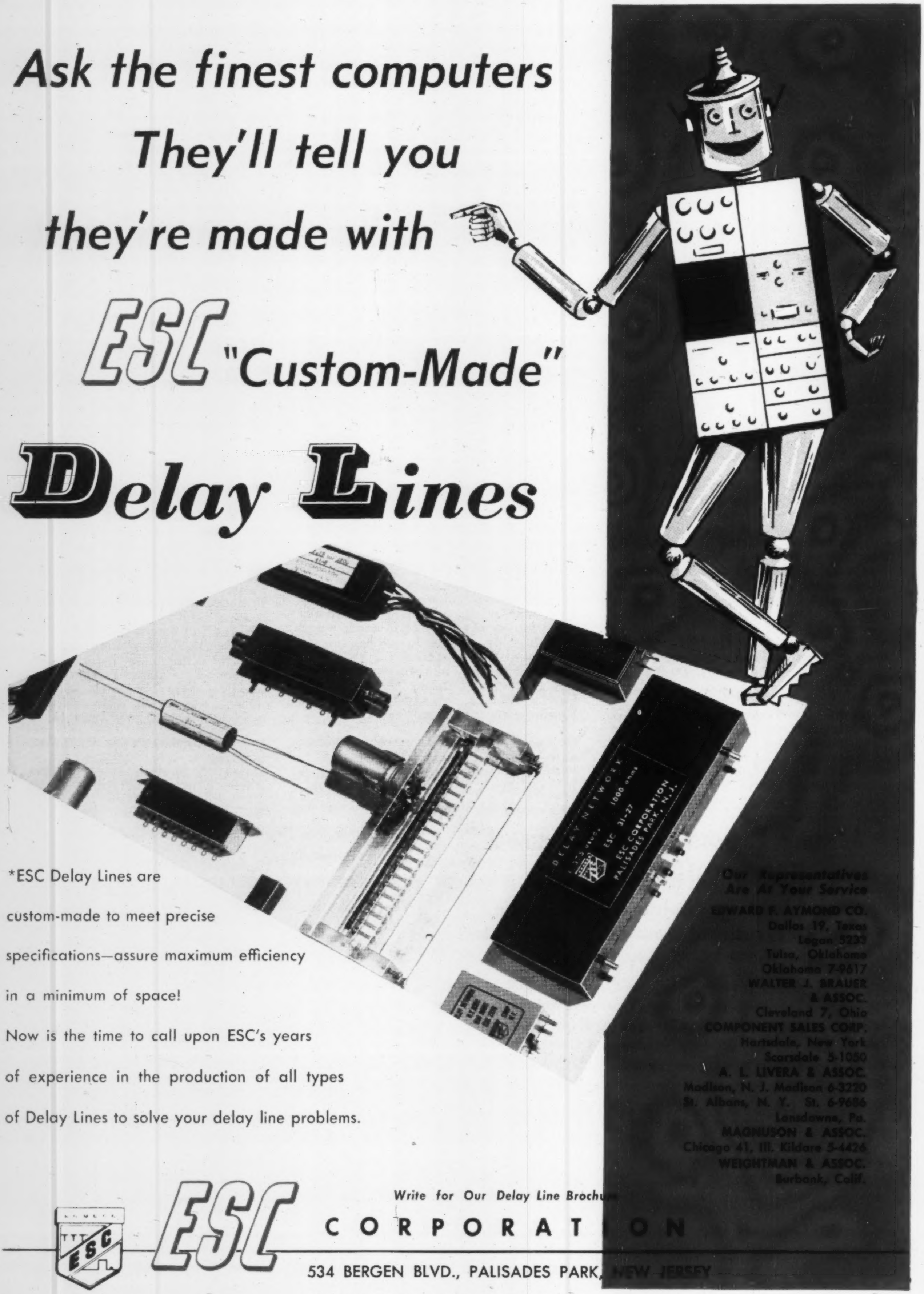
Address ....

....

Ask the finest computers They'll tell you they're made with

ESC "Custom-Made"

Delay Lines



*ESC Delay Lines are custom-made to meet precise specifications—assure maximum efficiency in a minimum of space!

Now is the time to call upon ESC's years of experience in the production of all types of Delay Lines to solve your delay line problems.

Our Representatives Are At Your Service

EDWARD F. AYMOND CO.
Dallas 19, Texas
Logan 5233
Tulsa, Oklahoma
Oklahoma 7-9617
WALTER J. BRAUER & ASSOC.
Cleveland 7, Ohio
COMPONENT SALES CORP.
Hartsdale, New York
Scarsdale 5-1050
A. L. LIVERA & ASSOC.
Madison, N. J. Madison 6-3220
St. Albans, N. Y. St. 6-9686
Lansdowne, Pa.
MAGNUSON & ASSOC.
Chicago 41, Ill. Kildare 5-4426
WEIGHTMAN & ASSOC.
Burbank, Calif.

Write for Our Delay Line Brochu

ESC CORPORATION
534 BERGEN BLVD., PALISADES PARK, NEW JERSEY

For more information circle **92** on inquiry card.

Process Control Analysis

Final step preparatory to analysis of a closed-loop control system mathematically is combining the open-loop system and controller equations to obtain the closed-loop system equation. The order of the final equation is determined by the number of capacities in the system. Accurate evaluation of all system constants is essential to the success of the analysis.

MILLARD H. LAJOY
University of Minnesota
and
E. ALLEN BAILLIF
Seeger Refrigerator Co.

III

THE CLOSED-LOOP EQUATIONS

OPEN-LOOP EQUATIONS for single-, two-, and three-capacity processes were developed in the opening chapter of this series. In Chapter II we developed the equations for the controller section of the controlled system (including the measuring element, the controller, and the final control element). The final step in the development of the mathematics that describe an automatically controlled system consists of combining the equations of the process with those of the controller to obtain the equations of the controlled closed-loop system.

There are a large number of possible combinations of controller and processes, and it would not be practical to give a tabulated comprehensive list of mathematical equations describing every situation that may arise; we will emphasize the *procedure* for obtaining closed-loop equations for single-, two-, and three-capacity processes combined with a controller section containing up to two time lags. This covers many situations that occur in practice, and reduces the number of equations to a minimum, thereby emphasizing the procedures rather than the equations themselves.

The Controlled Single-capacity Process

Let us first consider the most elementary type of process, a single-capacity system. Fig. 3-1 shows a single-capacity process and a controller containing two time lags (both the measuring element and the final control element contain appreciable time lags). The equation for a single-capacity process (Equation 1.3) and a controller containing two time lags (Equation 2.28) were developed previously. For convenience, they are repeated:

$$(1/R_q)\,(H\,dx/dt + x) - x_q/R_q = F \qquad 1.3$$

$$(T_m T_v)\,d^2F/dt^2 + (T_m + T_v)\,dF/dt + F =$$
$$-\alpha(x - x_o) - \gamma \int_o^t (x - x_o)\,dt - \beta\,dx/dt + F_o \qquad 2.28$$

where $\alpha = abc$; $\gamma = abcR$; $\beta = abcT$.

In the equations, the important terms are:

$T_m = R_m C_m$
$T_v = R_v C_v$
$H = R_q C$
α = the over-all proportional control factor
β = the over-all rate (or derivative) control factor
γ = the over-all reset (or integral) control factor

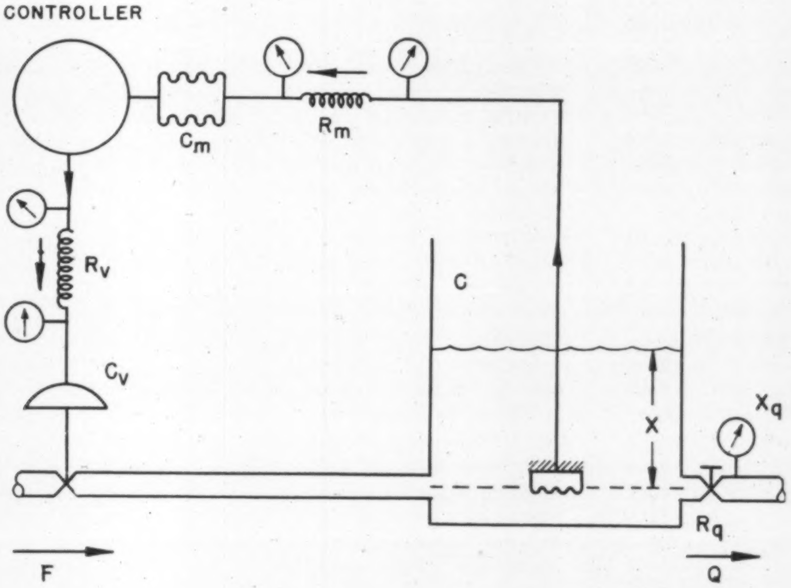


Fig. 3-1. Single-capacity process with ideal (lagless) controller, but with lag in both measuring system and valve. Equation for the closed-loop control system is a 3rd-order integro-differential equation, reflecting the three capacities in the system (C, C_m, and C_v).

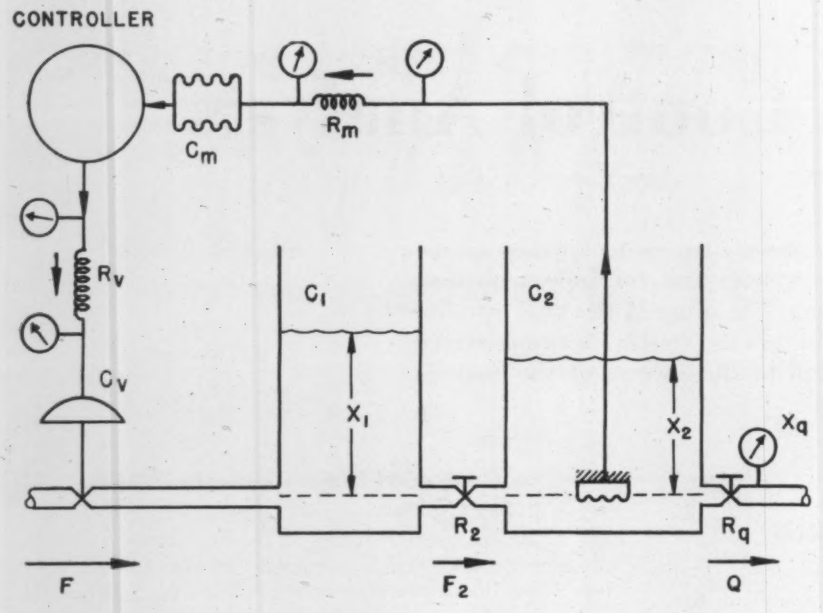


Fig. 3-2. Two-capacity process with ideal (lagless) controller, but with lag in both measuring system and valve. System equation for this closed-loop control application is a 4th-order integro-differential equation, reflecting the four capacities in the system (C_1, C_2, C_m, and C_v).

Combining equations 1.3 and 2.28 (by substituting F, dF, and d^2F from 1.3 in 2.28, and noting that x_q/R_q is a constant) yields:

$$T_mT_vH\ (d^3x/dt^3) + (T_mT_v + T_mH + T_vH)\ (d^2x/dt^2) + (T_m + T_v + H + R_q\beta)\ (dx/dt) + (1 + R_q\alpha)\ (x - x_o) + R_q\gamma \int_o^t (x - x_o)\ dt = x_q - x_{qo} \qquad 3.1$$

Equation 3.1 represents the closed-loop equation for a single-capacity process, an ideal controller, and a measuring element and final control element each possessing significant time lag. This equation is general for single-capacity systems (which can be represented as in Fig. 3-1). The equation includes a controller possessing all three types of control modes—proportional, derivative, and integral: if we desire to obtain the closed-loop equation for a single-capacity system where the measuring-element time lag can be neglected, and where there is no reset control action, it is necessary only to set the proper coefficients to zero and substitute these into equation 3.1. The terms T_m and γ would then be zero, and equation 3.1 would become:

$$T_vHd^2x/dt^2 + (T_v + H + R_q\beta)\ dx/dt + (1 + R_q\alpha)\ (x - x_o) = x_q - x_{qo} \qquad 3.1a$$

which is the closed-loop equation for a single-capacity system being controlled by a proportional plus derivative controller where both the measuring element and the controller are ideal, but where the final element has lag.

For another example of the general application of equation 3.1, let us assume that we desire the closed-loop equation for a single-capacity system where there are no time lags, and where only proportional control is being used. We would set T_m, T_v, β, and γ equal to zero.

Substituting these quantities into equation 3.1:

$$Hdx/dt + (1 + R_q\alpha)\ (x - x_o) = x_q - x_{qo} \qquad 3.1b$$

Equation 3.1b is the closed-loop equation for a single-capacity system where the entire controller section is considered ideal and where only proportional control is used. Equation 3.1 is general for single-capacity systems.

Controlled Two-capacity Process

A two-capacity process and a controller section possessing two time lags is shown in Fig. 3-2. The open-loop process equation (1.9) was developed previously. For convenience, it is repeated:

$$\frac{1}{R_q}\left(J_2\frac{d^2x_2}{dt^2} + J_1\frac{dx_2}{dt} + x_2\right) - \frac{x_q}{R_q} = F \qquad 1.9$$

where

$$J_2 = C_1C_2R_2R_q \qquad 1.10$$

$$J_1 = C_1R_2 + C_1R_q + C_2R_q \qquad 1.10$$

To obtain the closed-loop-system equation, it will be necessary to combine equation 1.9 with the general controller equation 2.28, which was repeated in the previous section dealing with the single-capacity process.

Combining these equations (as done to obtain 3.1):

$$T_mT_vJ_2d^4x_2/dt^4 + (T_mT_vJ_2 + T_mJ_2 + T_vJ_2)\,d^3x_2/dt^3 + (T_mT_v + T_mJ_1 + T_vJ_2 + J_2)\,d^2x_2/dt^2 + (T_m + T_v + J_2 + R_q\beta)\,dx_2/dt + (1 + R_q\alpha)\,(x_2 - x_o) + R_q\gamma \int_o^t (x_2 - x_o)\,dt = x_q - x_{qo} \qquad 3.2$$

Equation 3.2 represents the closed-loop equation for the general case of a two-capacity process being controlled by an ideal controller but with measuring element lag and final-control-element lag. It is a fourth-order integro-differential equation (effectively a fifth-order differential equation). *The order of the integro-differential form of the equation will always equal the number of capacities in the closed-loop system.* In Fig. 3-2 there are two capacities in the process, and the equivalent of two capacities in the controller section of the loop. It is a comparatively lengthy expression, but once the numerical values of the process constants are substituted, it would reduce to a simple, linear differential equation having constant coefficients, which can be solved by well-known methods.

Equation 3.2 represents the general case; it can be used to obtain the equations for systems which are less involved. For example, let us consider the case where there are no lags, and where the only mode of control being used is integral. The following terms would be set equal to zero: T_m, T_v, α, and β. Substituting the above into equation 3.2, we obtain:

$$J_2d^2x_2/dt^2 + J_1dx_2/dt + (x_2 - x_o) + R_q\gamma \int_o^t (x_2 - x_o)\,dt = x_q - x_{qo} \qquad 3.2a$$

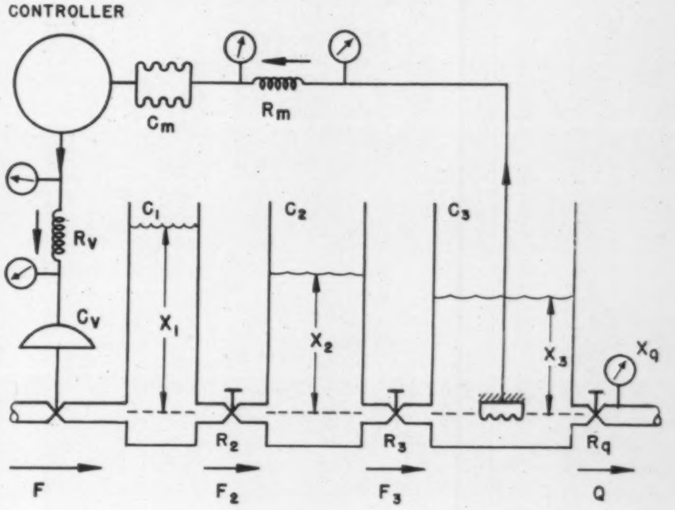


Fig. 3-3. Three-capacity process with ideal controller, but with lag in measuring and valve circuits. System equation is a 5th-order integro-differential equation, reflecting the five capacities in the system (C_1, C_2, C_3, C_m, C_v).

Once the general equation is written (such as equation 3.2 for the two-capacity system, and equation 3.1 for the single-capacity system) it is easy to obtain the closed-loop equation for any possible combination of controller modes that is being used on the process.

Controlled Three-capacity Process

The final process to be considered is a relatively complex system, as shown in Fig. 3-3. This three-capacity process, under control by a controller section containing two time lags, will yield a fifth-order integro-differential equation. The open-loop equation of this process (equation 1.17) has been developed previously, and is repeated:

$$\frac{1}{R_q}\left(K_3\frac{d^3x_3}{dt^3} + K_2\frac{d^2x_3}{dt^2} + K_1\frac{dx_3}{dt} + x_3\right) - \frac{x_q}{R_q} = F \qquad 1.17$$

where

$$K_3 = C_1C_2C_3R_2R_3R_q \qquad 1.18$$

$$K_2 = C_1C_2R_2R_3 + C_1C_2R_2R_q + C_1C_3R_2R_q + C_1C_3R_3R_q + C_2C_3R_3R_q$$

$$K_1 = C_1R_2 + C_1R_3 + C_1R_q + C_2R_3 + C_2R_q + C_3R_q$$

As additional capacity is added to the system, the expressions become lengthy, and care must be exercised in the evaluation of the coefficients. Combining equation 1.17 with 2.28 (as done to obtain 3.1) yields:

$$T_mT_vK_3\frac{d^5x_3}{dt^5} + (T_mT_vK_2 + T_mK_3 + T_vK_3)\frac{d^4x_3}{dt^4} +$$
$$(T_mT_vK_1 + T_mK_2 + T_vK_2 + K_3)\frac{d^3x_3}{dt^3} +$$
$$(T_mT_v + T_mK_1 + T_vK_1 + K_2)\frac{d^2x_3}{dt^2} +$$
$$(T_m + T_v + K_1 + R_q\beta)\frac{dx}{dt^3} + (1 + R_q\alpha)(x_3 - x_o) +$$
$$R_q\gamma\int_0^t (x_3 - x_o)\,dt = x_q - x_{qo} \qquad 3.3$$

Equation 3.3 represents the general case of a three-capacity system being controlled by a controller section containing two time lags. It is a lengthy expression, but once the system constants are inserted, we obtain single numerical values of all coefficients. Also, equation 3.3 involves a controller possessing proportional, derivative, and integral control response. As described previously, the same equation can be used for obtaining the closed-loop equation for a less-involved *controlled three-capacity process*. For example, let us consider a three-capacity process being controlled by an ideal controller with proportional control only, and with no time lags anywhere in the system. Therefore, the following terms would be set equal to zero: T_m, T_v, β, and γ.

Substituting these relationships into equation 3.3:

$$K_3\frac{d^3x_3}{dt^3} + K_2\frac{d^2x_3}{dt^2} + K_1\frac{dx_3}{dt} +$$
$$(1 + R_q\alpha)(x_3 - x_o) = x_q - x_{qo} \qquad 3.3a$$

Thus, once the general expression is obtained for a given process and controller, it is simple to obtain other closed-loop equations.

Conclusions

We have completed the task of combining the process and the controller equations to obtain the closed-loop system equation. Several processes and controller combinations have been described to enable one to apply the procedures to analogous cases. Once the closed-loop expression is obtained for a given system, it is possible to analyze mathematically the type of response that can be expected for a step-type disturbance, which is the type of disturbance often assumed for mathematical developments. A step-type disturbance is severe, and a process which responds satisfactorily when subjected to such an upset should prove successful in practical application.

The success of any mathematical analysis, whether done by the procedures described or by other methods, depends on the *accurate evaluation of the system constants*. This means that careful calculation must be made of the process resistances and capacities, as well as the time lags in the measuring and valve sections of the loop. It also may be necessary to consider the time lag within the controller in fast processes (such as flow control or pressure control) where the time lag within the process is small. This has not been considered; however, it would result only in adding another resistance-capacity stage in the controller.

All of our developments up to now have been in a general manner, with the objective of obtaining the closed-loop equation. Our next step will be to examine these equations analytically, and to apply them to some practical applications to illustrate the use of closed-loop equations, as in predicting the performance of an actual system when subjected to a step-type disturbance.

To be continued

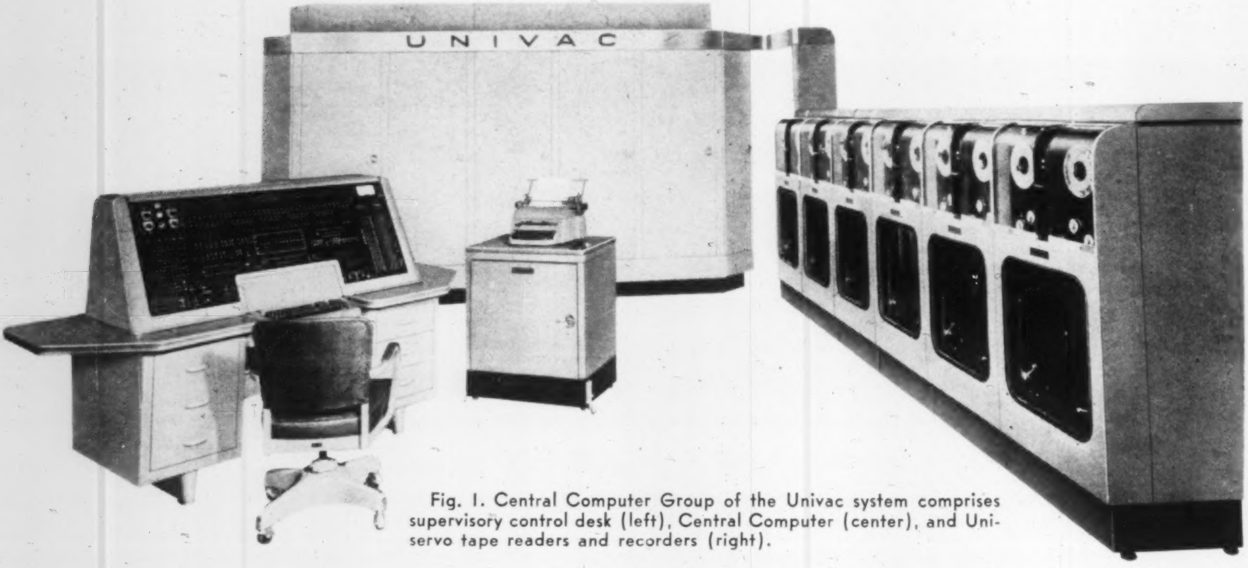


Fig. 1. Central Computer Group of the Univac system comprises supervisory control desk (left), Central Computer (center), and Uniservo tape readers and recorders (right).

Univac (Universal Automatic Computer) and Univac Scientific are typical of the large-scale electronic digital computers that open new and vast fields for office and engineering automation. Here is a thorough résumé of the Univac and Univac Scientific, with emphasis on the real-time features of the latter.

WILLIAM ALLEN and **GRAHAM E. SMITH**
Remington Rand Inc.

The UNIVAC and

THE UNIVAC SYSTEM FOR AUTOMATIC DATA-PROCESSING

William Allen

ELECTRONIC COMPUTER art has made tremendous progress in the few years since the first one was completed in Philadelphia in 1945. In the first week of October, 1954, at the Major Appliance Division of General Electric in Louisville, Kentucky, a large-scale electronic digital computer, Remington Rand's Univac (UNIVersal Automatic Computer) produced payroll checks for distribution to General Electric employees. The data-processing involved was completely automatic from the transcription of the raw data to the production of the final documents. This was the first major example of electronic automation in the office—a type of operation to which the Univac System is exactly fitted.

The essential characteristic of office automation is the complete mechanization of all steps of the processing operation, from beginning to end.

Elements of Univac System

The system consists of two major groups of equipment: (1) The *Central Computer Group* (Fig. 1) which processes information fed to it from magnetic tape and records the results onto magnetic tape; and (2) the *Auxiliary Equipment* needed to put information onto magnetic tape and translate into understandable form the magnetic recording of the processed results.

The *Central Computer Group* (Fig. 1) includes the Supervisory Control (left) with its printer and oscilloscope, Uniservos (right), and Central Computer (center), which is the "heart" of the system.

The Central Computer of the Univac, like most large-scale general-purpose computers, has five general sections, each with a separate function. These sections are (1) *input* circuits, controls, and buffer storage, (2) *storage* facilities (memory) for information and instructions, (3) *arithmetic*, or *processing*, circuits, (4) *control* circuits, including *checking circuits*, and (5) *output* circuits, controls, and buffer storage.

Input Circuits

Input Circuits include means of introducing information to the computer in a way immediately useful to the processing circuits. Early in the development of the Univac system it was decided that the most practical method of providing input to the computer was by magnetic tape. When the computing system is to be used for handling the masses of information required by large business and industries (rather than for performing long and complex operations on a small amount of informa-

---

Presented at the Computer Clinic, First Automation Exposition, New York, N. Y., Nov. 30-Dec. 2, 1954.

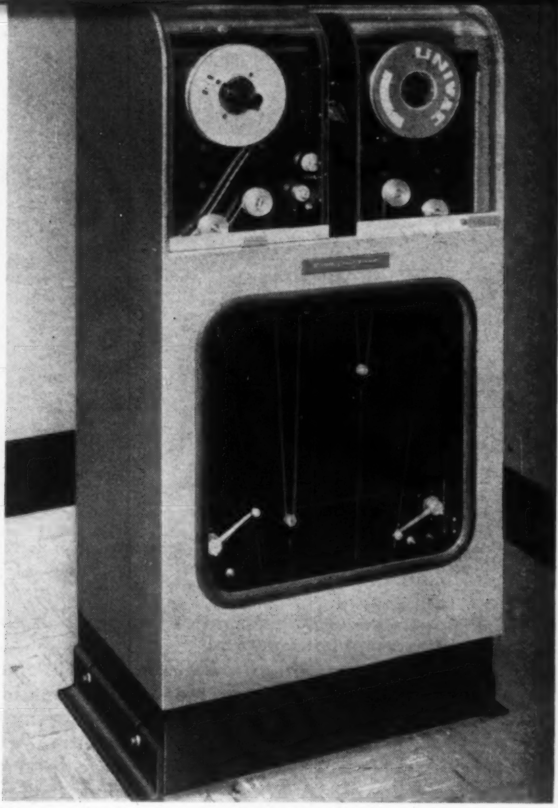


Fig. 2. A Uniservo, the magnetic-tape reader and recorder used in the Univac system. Uniservos are essentially high-speed tape handlers, and are used as both input and output elements with the Central Computer.

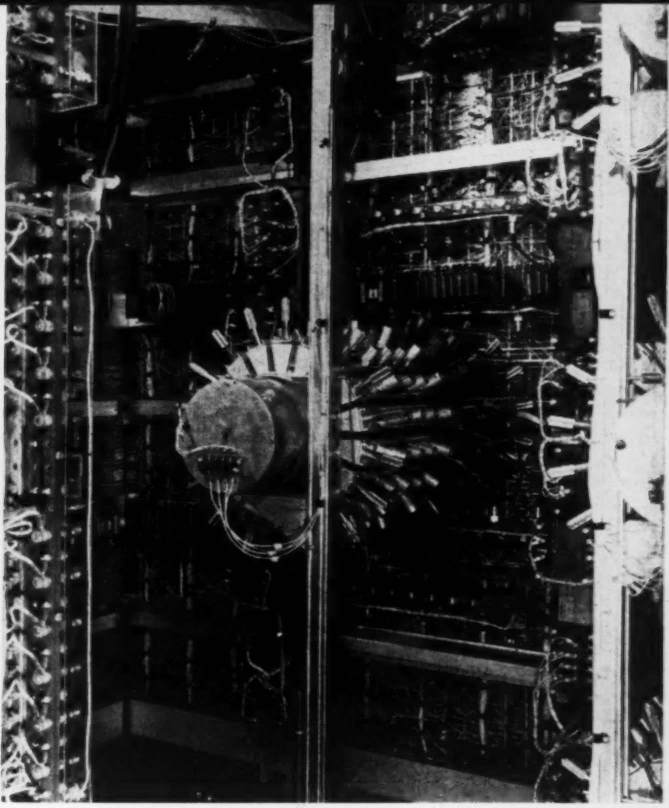


Fig. 3. A mercury memory tank (or acoustic delay line) containing 18 separate 10-word channels, each word consisting of 12 alphabetic or numeric characters.

UNIVAC SCIENTIFIC

tion) no other method is as fast, or as compatible to the requirements of an electronic system. The development of the Univac metal magnetic-tape provided a means of entering data into a computer, and receiving results from it, at speeds commensurate with the speed of internal operation.

Uniservos

The tape is handled by high-speed tape-transport devices know as *Uniservos* (Fig. 2), whether it is used for input or for output. Input tapes are read into the Univac under the control of semi-independent tape controls; the computer merely signals these controls to read, and then, while the read operation is taking place, goes on with other computer operations.

The tape controls finish the operation, taking the data, arranging it in proper sequence (the Univac can read either backwards or forwards, and the information still enters the computing circuits in the proper order), and timing it into the internal synchronization of the central computer. Then, as it is synchronized, it is entered into *buffer storage*, a special section of the mercury memory (separate from the addressed computer storage), where it is held until the computer is ready for it. Then it is sent to the addressed storage, ready for processing.

Storage

There are 1000 addressed memory locations in the Univac, each containing one computer "word" of 12 alphabetic or numeric characters. The information contained in the memory is held by means of an acoustic delay (Fig. 3). Information travelling at the speed of light enters a column of mercury as a shock wave which passes through the mercury at the speed of sound; at the other end of the column it is picked up, amplified, resynchronized, and reshaped. Then it can be either sent out for use in other parts of the computer, or recirculated through the mercury.

The memory is checked automatically to make certain that no information is lost or changed by being held there.

Data-Processing Circuits

The data-processing circuits (in the central computer) perform the actual arithmetic and logical operations on information received from the memory. There are two identical sets of data-processing circuits. The problem is run through both sets simultaneously, and compared at various stages. If both sections agree on their results, the flow of work proceeds. If there is any disagreement, Univac will stop so that the operator can take appropriate action.

When the computation has been performed, the result is returned to the memory, where it is either stored awaiting the next instruction or, if a final result, sent out of the computer as output and recorded on magnetic tape by the Uniservo.

Control and Sequence Circuits

Master control over all these operations is exercised by the Control and Sequencing circuits. The control circuits generate the signals that perform each individual instruction, and guide the information through the computer according to the instructions. The sequencing circuits automatically set up the individual instructions of the program and lead the problem step by step through to solution. These circuits, operating either completely automatically or under the guidance of the program, give to Univac its automatic character, and increase its versatility and speed.

Output

Information leaving the internal addressed storage is sent into a buffer storage unit, where it is held pending the movement of the tape. The output-control circuits, like the input-control circuits, are essentially independent of other computer operations: the computer signals them to work, and the memory provides the information, but the separate output controls perform the actual write operation without interference from the computer. As a result of these independent input and output controls, Univac can read, write, and compute simultaneously. It is the only computer that can perform all three functions at the same time.

As the tape moves, the information is taken from the buffer storage, one character at a time, and fed to the magnetic recording head, which records the character in Univac code as a pattern of magnetic pulses on the tape.

Instructions

Univac recognizes and uses a repertory of 45 instructions. Seven of these are *arithmetic instructions* in the strict sense of the word: (1) transfer-and-add, (2) add, (3) subtract, (4) multiply-with-roundoff, (5) multiply-without-roundoff, (6) negative-multiply, and (7) divide. Eight of the 45 instructions are 1-word *transfers*, two are 2-word transfers, two are 10-word transfers, and two are 60-word transfers. (In a 1-word transfer, one word is transferred from the memory to one of the four 1-word registers, or vice versa. In 2-word transfer, two words are transferred from the memory to the one 2-word register, or vice versa. Similar transfer applies to the one 10-word register and the two 60-word registers. Greater flexibility will result from the use of newer magnetic core memory: words other than 1, 2, 10, and 60 in number will be transferrable in Univac II.)

In addition to the seven arithmetic instructions and eight transfer instructions, there are eight *tape instructions* and two *Supervisory Control instructions*: these ten carry the bulk of input-output operations, although other operations can be initiated from the control console. There are four instructions to control *right-* and *left-shift* (in relation to the decimal point) with or without sign. Two instructions *compare operands* to determine the necessity for transfer: a third instruction *transfers control unconditionally*; a fourth enables the programmer to *store* an unconditional-transfer instruction in a position determined by the program. Other instructions are the *extract instruction* (for changing single digits within a computer word), and *conditional and unconditional stop instructions*.

An *automatic overflow routine* is built into the computer's logic so that the programmer can compensate for an improper division or any operation that exceeds the capacity of the accumulator register.

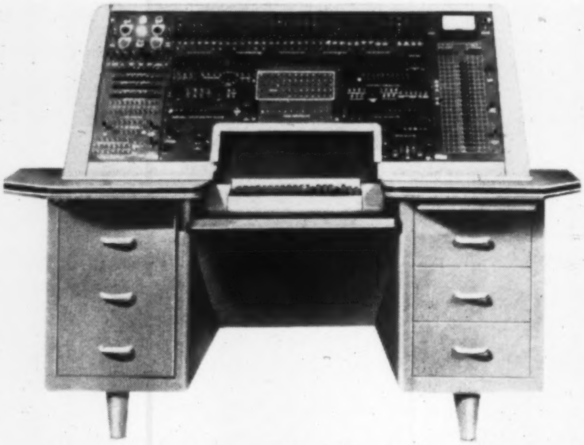


Fig. 4. Supervisory Control desk, at which operator controls the operation of the Central Computer of Univac.

The *compare-and-transfer instructions* enable the computer to sort either alphabetic or numeric information with equal ease. Sorting has been described as the most inefficient operation to which a tape-fed computing system can be applied; yet the ability of Univac to read forward or backward from tape with equal facility, coupled with the compare-and-transfer instructions, has reduced even this operation to the level of practicality: 12,000 ten-word items, for example, can be sorted to a 2-digit key in 21 minutes (any 2 digits can be the key for the sorting operation).

Advantages of Univac Central Computer

The Central Computer, which is the heart of the Univac System, is the component in which all processing (arithmetic and logical) operations take place. Analysis of the thirteen Univacs installed as of October, 1954, would probably include the following advantages as those of greatest significance:

1. *Treatment of exceptions*: In most accounting or data-processing procedures, the treatment of exceptional situations is an area in which mechanized systems make poor showing; due to limited capacity and flexibility, exceptional cases are normally set aside and treated manually. Although the number of exceptions is usually a small percentage of the total, a considerable amount of expense and delay is involved in treating them. Owing to the computer's ability to store in its memory the subroutines necessary to process each variation of the normal processing operations, exceptional cases need not be segregated but can be treated, automatically, as they arise.

2. *Elimination of manual intervention*: Punched-card systems and other semimechanized systems consist of a variety of machines, each with a single function or a cluster of similar functions. A sorter, for example, arranges cards; a collator merges card decks or selects cards; a gang-punch reproduces common information. Between each machine operation, a clerical operation may be required to transport cards and to assure against loss or misplacement of items. The automatic computer, where all required operations are performed in a single device, eliminates manual or clerical intervention to a surprising degree from the time raw data is recorded on magnetic tape to the time the final edited output is printed.

3. *Speed of computation*: Speed of computation, made possible by electronic techniques, is the basic advantage

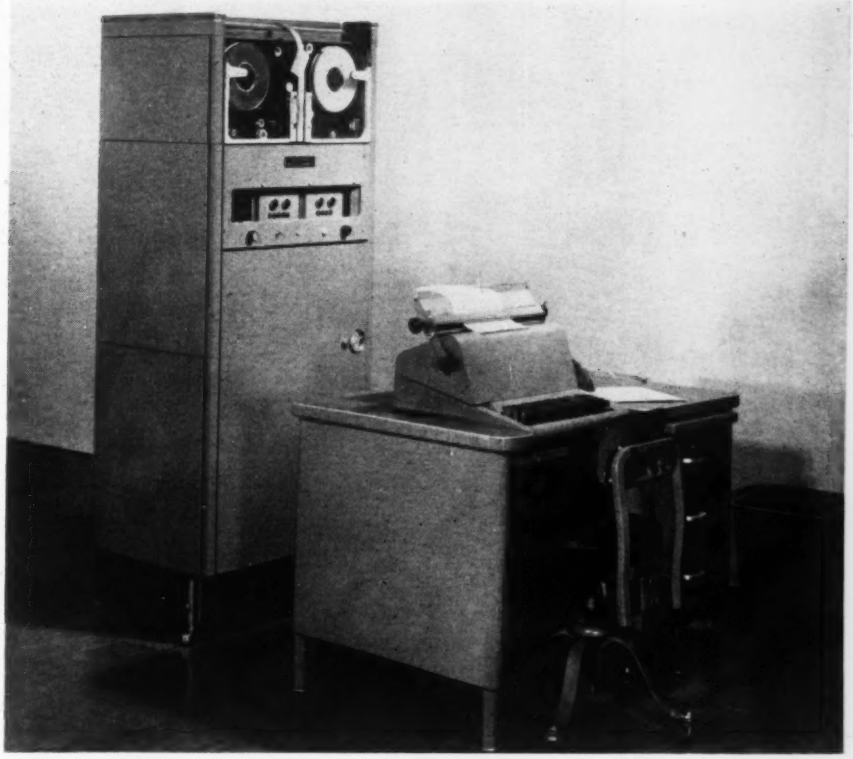


Fig. 5. Unityper I puts raw data on tape for use by the Uniservos.

of modern computers. Example: The Air Materiel Command, using their Univac system at Wright-Patterson Air Force Base, recently completed, in one day, the complete Fiscal 1956 Budget estimate for airborne-equipment spare parts, involving approximately 500,000 items. A large battery of the most modern punched-card equipment previously had required weeks to complete this same work.

4. *Accuracy of computation*: Equally important as speed is the accuracy of the processing operation, made feasible through circuit design and error-detector features built into the system. Univac has 35 basic checking circuits, and completely duplicate processing circuits; these features constitute about 30 percent of the total equipment in the Central Computer. Owing to the extensive self-checking in Univac, including the duplications, the user does not have to rely on test runs, nor on the programmer's skill in coding program checks. In addition, a maintenance man can isolate a faulty circuit easily because the computer stops at the instant a fault is detected.

Supervisory Control Console

The operations of the Central Computer are controlled and supervised by the human operator at the Supervisory Control Console (Fig. 4). It is from this station also that the maintenance staff performs the initial analysis and isolation of any machine malfunction. The control desk consists of a large panel (on which the indicator lights and control switches are located) and a communicating keyboard. The keyboard is the means by which the operator "talks" to the computer.

An associated printer (shown in Fig. 1), similar to the printing unit of the Uniprinter, permits the computer to "talk back" under the control of the program or at the discretion of the operator. By using this printer, the operator can read out from any memory location, from any of the arithmetic and transfer registers, and even from the control registers.

Monitor Oscilloscope

A Monitor Oscilloscope (shown on the cover) is a valuable part of the console group, joining with the indicators on the control panel to permit the operator to observe the internal operations of the computer at any time. Switches on the control panel can be used to interrupt the automatic operation of Univac if necessary, and to start, stop, and alter the course of the program.

Uniservos

Uniservos are high-speed devices for handling magnetic tape. They can feed information into the Central Computer at speeds to 12,800 digits (numbers or letters) per second; the computer can record results on tape at the same peak speed. The Uniservos operate as an integral part of the Central Computer group, under directions from the computer (Figs. 1 and 2).

Univac recording tape is a specially plated metal tape on which information can be recorded in the form of patterns of magnetic impressions. There are many advantages to using this type of tape as a means for putting information into the computer and recording the results: (1) It is compact; one 8-inch reel holds the equivalent of two 4-drawer tabulating-card files containing more than 20,000 cards. (2) It is virtually indestructible; under extremes of heat and cold, neither the tapes nor the recorded information is affected. (3) It is reusable and long-lived; tapes can be re-read thousands of times. The information can be erased at anytime and other information recorded.

Auxiliary Equipment

The Central Computer Group is a system complete in itself, operating on magnetic tape. It takes information, processes it sequentially at electronic speeds, and produces the desired results. However, both the input and output are on magnetic tape. Auxiliary equipment is needed to put the data to be processed and the processing

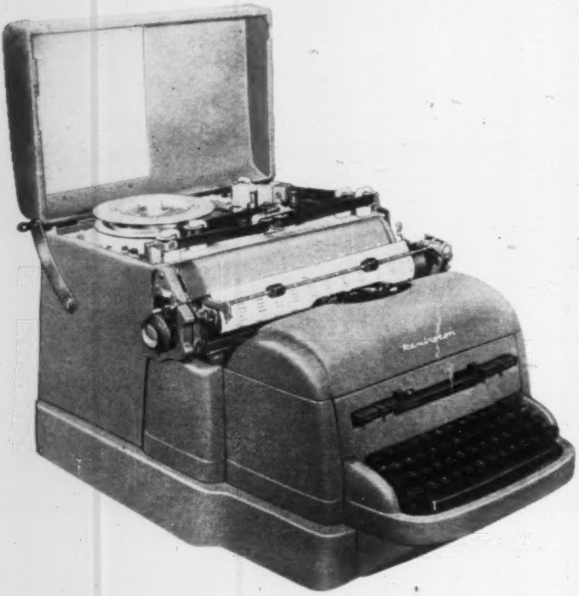


Fig. 6. Unityper II is simpler version of Unityper I.

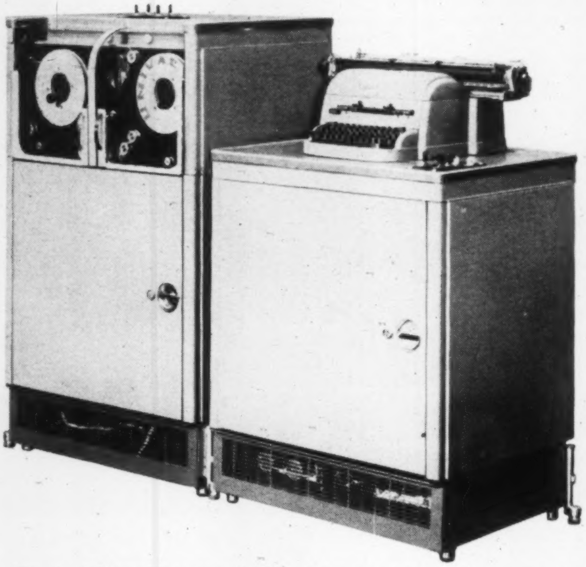


Fig. 8. Intermediate-speed Uniprinter consists of a tape reader and printing unit. It is an auxiliary output device for the Central Computer.

instructions on magnetic tape and, conversely, to translate the end results into understandable form.

Unityper I

Raw data that has never been processed before is usually prepared for the computer on a Unityper. The keyboard of the Model I Unityper (Fig. 5) consists of a regular typewriter keyboard, an auxiliary numeric keyboard for the high-speed typing of numbers, and a bank of control keys. Its cabinet contains not only the circuits that translate keyboard material into pulse patterns on tape, but also a special "automatic operator" apparatus that permits the automatic recording of certain types of reiterative material. Thus, the Unityper I is ideally suited to the preparation of program tapes, or any other type of repetitive information pattern.

Unityper II

The Model II Unityper (Fig. 6), a recent development, provides another means for typing information on tape. Many of the control devices, including the "automatic operator" apparatus, are eliminated from Unityper II for simplicity and compactness; its keypoard is that of a slightly modified Remington electric typewriter. Although it cannot save as much time as Unityper I in typing of reiterative material, it can perform many of the same jobs at a fraction of the cost.

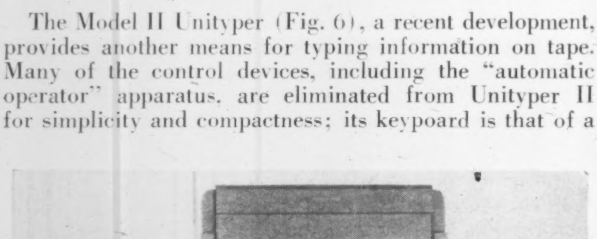


Fig. 7. Card-to-magnetic-tape Converter processes 240 cards per minute, and puts data on magnetic tape for Uniservos.

Card-to-tape Converter

Punched-card information can be prepared for Univac by the Card-to-magnetic-tape Converter (Fig. 7), which automatically translates information from punched cards into magnetic impressions on tape. The converter processes 240 cards a minute, producing a tape record of the material on the cards. Accuracy is ensured by built-in checking circuits, which include means for reading each card twice and comparing the second reading with the tape recording of the first reading. If an inconsistency is discovered, the card is ejected for attention. Once information is transcribed from punched cards to magnetic tape, the cards need no longer be kept on file because the information can be stored permanently as a magnetic recording.

Uniprinter

The Central Computer records its results on reels of magnetic tape. These results can then be printed out on the Uniprinter (Fig. 8), which consists of a tape reader and a printing unit. The printing unit is a Remington electric typewriter, operated by the magnetic impulses read from the tape by the tape reader.

High-speed Printer

For printing large quantities of processed data, the revolutionary new High-speed Printer is used (Fig. 9). This printer can print ten lines of 130 characters each per second, in any desired format. Photoelectric techniques are used to synchronize the triggering mechanisms for the print hammers to obtain this remarkable speed.

Tape-to-card Converter

The *Tape-to-card Converter* (Fig. 10) transfers information from Univac's magnetic recordings into punched cards at the rate of 120 cards a minute. Checking circuits enable the converter to read the cards back and compare the punched-card information with the original tape recording, ensuring the accuracy of the process. Cards containing inconsistencies are automatically rejected.

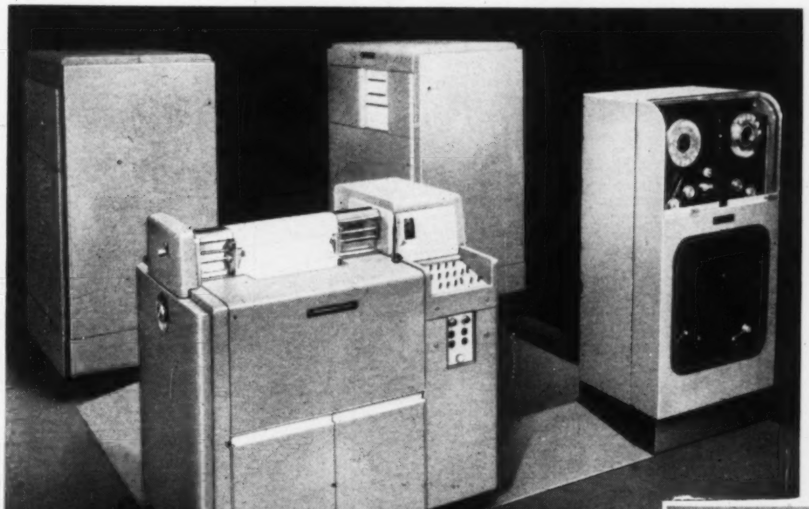
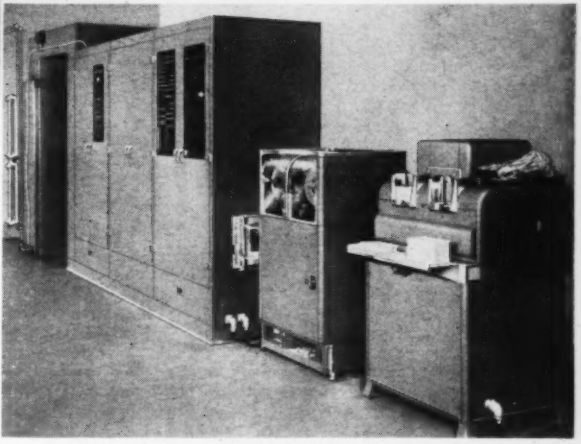


Fig. 9. High-speed printer, another auxiliary output device for the Central Computer, can print ten 130-character lines per second (600 lines per minute).

Fig. 10. Tape-to-card Converter transfers data from tape to punched cards at rate of 120 cards per minute.



Applications of Univac

The first Univac System was accepted by the U. S. Bureau of the Census in March, 1951. American industry has now grasped the full significance of electronic data-processing systems: 13 "office Univac" Systems are already delivered, and more than a dozen commercial contracts await delivery during 1955 and 1956.

The first six Univac Systems were delivered to government and defense agencies—the Bureau of the Census, the Office of the Air Comptroller, the Army Map Service, the Bureau of Ships of the U. S. Navy, and two to the Atomic Energy Commission. Then followed several commercial installations: General Electric in Louisville, Kentucky; Metropolitan Life Insurance Company in New York; Remington Rand's New York Computing Center; the National Tube Division of U. S. Steel in Pittsburgh, Pa.; the DuPont Corporation in Wilmington, Del.; a second Univac to U. S. Steel at Gary, Ind.; and one to Franklin Life Insurance Co. in Springfield, Ohio. The Air Force procured a second Univac with the Air Materiel Command installation at Wright-Patterson Air Force Base, Dayton, Ohio, and the Census installed their second on the same site as their first.

Other interesting contracts to be fulfilled include Pacific Mutual Life Insurance Company, the Chesapeake and Ohio Railroad, and Sylvania Electric Products Corporation. Remington Rand has opened a West Coast Computing Center in Los Angeles.

Do You Need a Large-scale Computer?

The prospective user must establish his need for such computers. In March 1953, with this philosophy in mind, we established a training division within the Electronic Computer Department of Remington Rand. These courses can provide information about the large-scale computer so that persons acquainted with their own data-processing problems can undertake an evaluation of potential economies. This is more efficient than educating a computer specialist in the ramifications of the specific commercial or accounting problem of a particular company.

We recommend that interested firms select two or three employees who are thoroughly familiar with their own business transactions to be trained in the logic and programming of large-scale computers—by Remington Rand or any other computer manufacturer. The basic theory of all large-scale computers is similar; education in one system is translatable to another. Following training, a survey can be instituted within defined areas of application in order to determine the economies of ordering a computer.

The personnel selected to receive training and to conduct the survey do not have to be mathematicians or engineers; they need only be open-minded and familiar with every detail of the operations to be evaluated. The analysis of systems and procedures, together with flow-charting, comprises about three quarters of the total work involved in preparing the necessary instructions required by the computer (generally referred to as programming). Coding the flow-chart into computer language is far less work.

An interesting point is that even though a computer purchase may not be warranted by the results of the survey, improved procedures will inevitably result from the minute detail that must be incorporated into any procedure survey. Such surveys quickly bring to light inefficiencies that may exist.

Prospective Developments

Remington Rand today possesses three extensive facilities devoted to the development of electronics: the Laboratory for Advanced Research at Norwalk, Connecticut; the Eckert-Mauchly Division at Philadelphia, Pennsylvania; and the Engineering Research Associates Division at St. Paul, Minnesota. In total, over 2,500 engineers, tech-

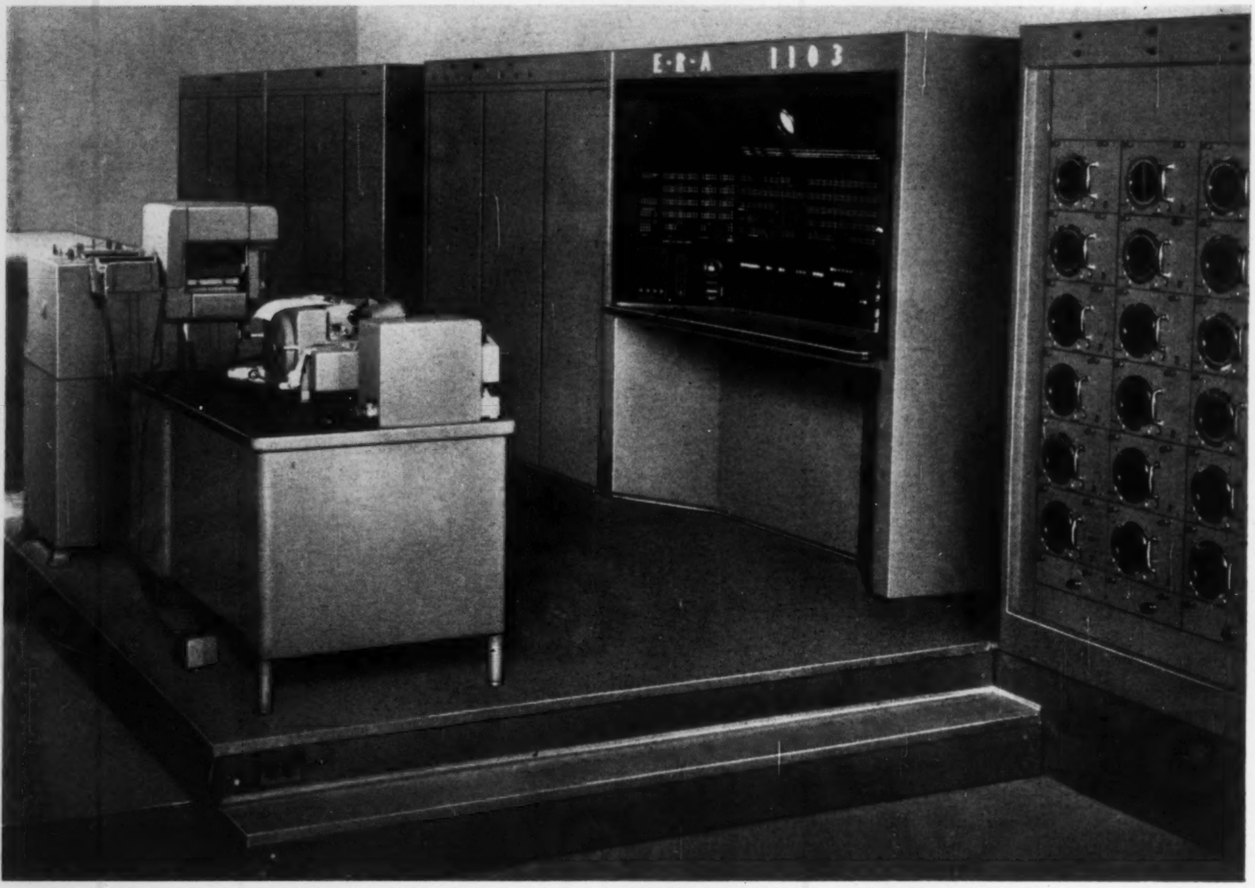


Fig. 11. Univac Scientific Computer, formerly called the ERA 1103, is a general-purpose high-speed computer featuring binary operation, 36-bit word size, 44 instructions, and internal storage memory of magnetic drum and magnetic core.

nicians, and scientists are at work; improvements will be forthcoming in both the Central Computer and the peripheral equipment.

Two such developments can be mentioned. During 1955, a *keyboard-operated magnetic-tape verifier* will be available in production quantities. This unit functions as a triple-purpose machine—(1) to record information onto magnetic tape from original documents, (2) to function as an intermediate-speed printer, or (3) to verify information previously recorded on a reel of magnetic tape. Its third function is certainly the most important because, for the first time, a means for tape verification will be available that is economically competitive with punched-card verification.

A second development is a converter to provide automatic translation between punched-paper tape and magnetic tape. These units will be forerunners of an extensive program to provide communication facilities between the decentralized points where data may originate and the central data-processing facility.

In summary, the year 1954 represented the coming of age of the large-scale electronic computer for application within business and industry. Tangible dollar savings of staggering proportions are made possible by application of electronic techniques to the solution of familiar and common tasks—payroll accounting, revenue accounting, inventory control, and the like. Although companies justify the procurement of electronic systems on the basis of these savings, the longer range significance of the electronic computer may lie in another direction. Greater economic rewards will result from applying electronic-computer methods to fields such as operations research and scientific management, particularly linear programming techniques to optimize the output of production lines, or assuring maximum profit through optimization of product mix. The forecasting of sales can be envisioned, and the rapid readjustment of complex production schedules. The large-scale electronic computer is ready for all of these potential areas of application.

UNIVAC SCIENTIFIC COMPUTING SYSTEM

Graham E. Smith

UNIVAC SCIENTIFIC COMPUTER—formerly called the ERA 1103—is shown in Fig. 11. It is a general-purpose, high-speed computer of large capacity. Its internal arithmetic operations are in the parallel mode (that is, the 36 pulses comprising one word advance "broadside" and are operated on simultaneously, unlike the Univac in which the pulses advance serially in a series stream and are operated on individually). Computer information is represented in pure binary form; the basic word size is 36 bits. A word may be an instruction, a number, or an arbitrarily coded quantity.

A form of two-address logic is employed. An instruction word consists of a 6-bit operation code and two 15-bit execution addresses. The functions of the execution addresses are different for the various types of instructions, but in most cases they specify registers in the memory from which operands are to be obtained, or in which results are to be stored. There are 44 instructions in the computer's repertory.

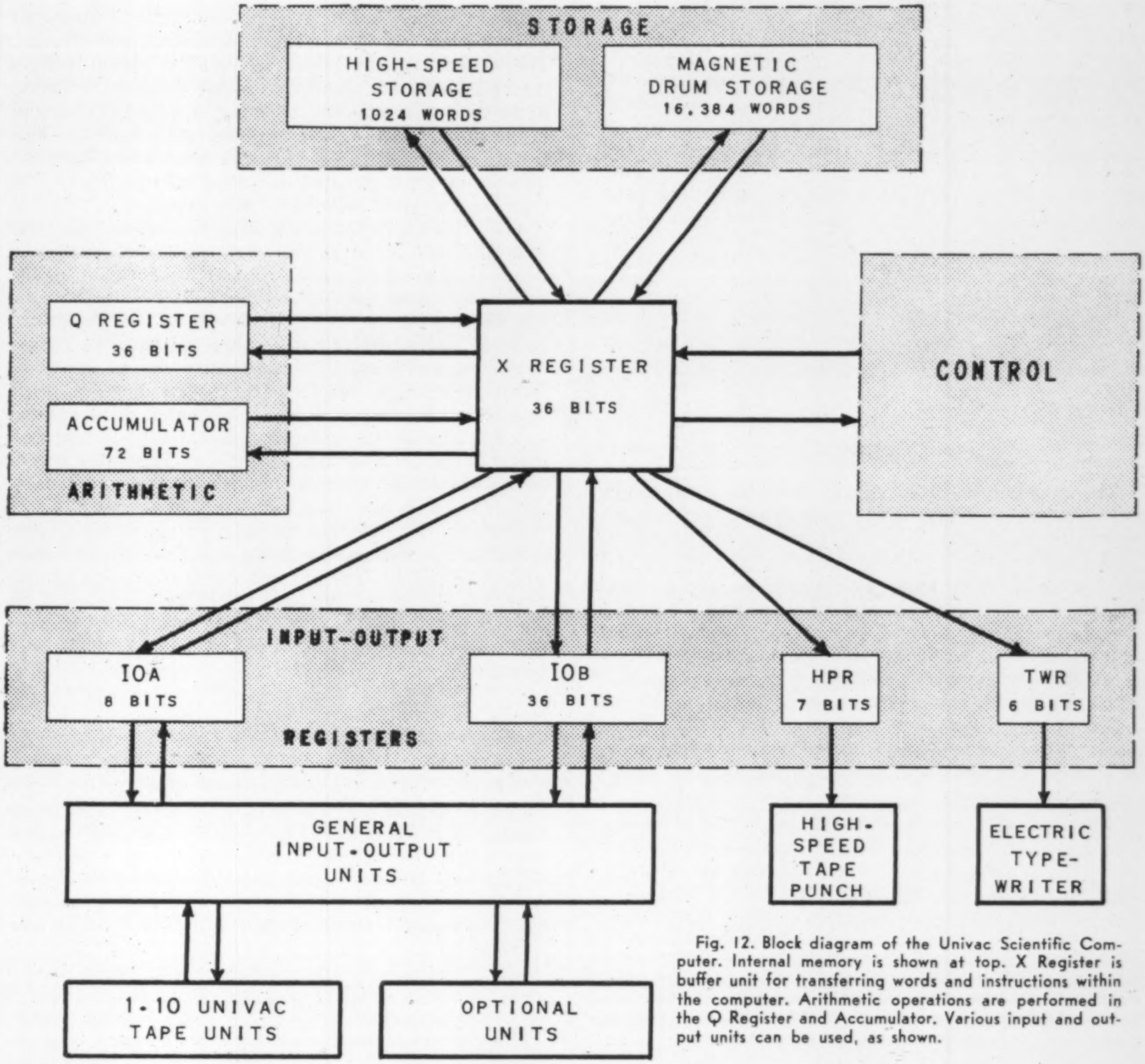

STORAGE
HIGH-SPEED STORAGE 1024 WORDS
MAGNETIC DRUM STORAGE 16,384 WORDS
Q REGISTER 36 BITS
ACCUMULATOR 72 BITS
ARITHMETIC
X REGISTER 36 BITS
CONTROL
INPUT-OUTPUT
IOA 8 BITS
IOB 36 BITS
HPR 7 BITS
TWR 6 BITS
REGISTERS
GENERAL INPUT-OUTPUT UNITS
HIGH-SPEED TAPE PUNCH
ELECTRIC TYPE-WRITER
1-10 UNIVAC TAPE UNITS
OPTIONAL UNITS

Fig. 12. Block diagram of the Univac Scientific Computer. Internal memory is shown at top. X Register is buffer unit for transferring words and instructions within the computer. Arithmetic operations are performed in the Q Register and Accumulator. Various input and output units can be used, as shown.

Storage

A functional block diagram of the computer is shown in Fig. 12. The internal memory (top) consists of 16,384 registers of magnetic-drum storage, and 1024 registers of high-speed magnetic-core storage. Additional registers of high-speed storage are available in increments of 1024, to a total of 4096 (Fig. 13). Supplementary memory is provided by up to ten external Univac magnetic-tape units (Fig. 2) which operate under program control. These units make the computer's input and output tapes compatible with the Univac High-Speed Printer, Tape-to-Card Converter, and other equipment from the Univac business system (described previously).

All of the 17,408 to 20,480 registers of magnetic-drum and high-speed storage are individually addressed, and each may be directly referred to by the instructions in the program. This direct-access property, combined with an interlace feature which staggers the physical location of consecutively addressed drum locations, increases the effective speed of the machine. The running time for a routine stored on the drum, with its operands in high-speed storage, may be made comparable with the running time for the same routine with both instructions and operands in high-speed storage. For many problems this has the effect of multiplying the effective capacity of high-speed storage by a substantial factor.

X Register

Most of the internal word transmissions in the Univac Scientific takes place by way of a 36-bit buffer unit known as the *X register*, which is a simple static register. This register holds the multiplicand and the divisor during multiplication and division.

Arithmetic Section

The two principal units of the *arithmetic section* are the *Q register* and the *accumulator*. The 36-bit Q register holds the multiplier, the quotient, or (in some instructions) a logical operator.

The second arithmetic unit is the 72-bit accumulator. Numbers are added to or subtracted from the least significant 36 bits of the accumulator; in other words, the computer's arithmetic treats numbers as integers whose binary point is at the extreme right. A succession of 36-bit quantities may thus be added into this truly double-length accumulator without overflow. Furthermore, the full 72-bit product of two 36-bit quantities may be formed in the accumulator.

Through the MULTIPLY ADD instruction, the full product of two numbers in storage may be added to the previous contents of the accumulator. In division, the accumulator initially contains the dividend, and at the end holds the remainder. The machine will handle a 72-bit dividend, but the quotient must fall within 36-bit range.

Both Q and the accumulator can be addressed like the other memory registers so that instructions may refer to these two arithmetic units as sources or destinations for operands.

Input-Output Units

The input-output section can accommodate many terminal equipments, as required by each installation. A high-speed tape punch and an electric typewriter are necessary.

Optional terminal equipment includes card-reading and card-punching units, line-at-a-time printers, special magnetic-tape units, analog-to-digital converters operating from sensing instruments, oscilloscope displays, point plotters, data-link modulator and demodulator units, and signal circuits to process-controlling devices. Communication with these units takes place by way of two *in-out registers*, (the 8-bit IOA and the 36-bit IOB). These registers permit simultaneous use of many external units, and allow computation to proceed while terminal equipment is functioning.

There are three instructions by means of which the computer deals with external units connected to the IOA and IOB. These are EXTERNAL FUNCTION, EXTERNAL READ, and EXTERNAL WRITE.

The EXTERNAL FUNCTION instruction (EF-v) selects and activates a piece of terminal equipment in a specified mode of operation. (Symbols v, j, n, w, etc., represent numbers which would specifically identify and locate a word and its address.) This is the instruction whereby the computer program can reach out, so to speak, and push buttons on external units. The selected operation may involve a single data transfer to or from IOB (as in interrogating a shaft-position digitizer or plotting a single point on an X-Y plotter) or it may be a "free-running" operation (as reading or punching of a succession of lines on Teletype tape). The unit and its mode of operation are designated by a 36-bit code stored at the address v given in the instruction.

A selected external unit will either deposit information in (or read information from) the in-out register to which it is connected. In the first case, the computer must be able to pick up and utilize the quantity so deposited. The EXTERNAL READ instruction (ERjv) causes the contents of IOA or IOB (as specified by j) to be transmitted to the memory location (of address v). In the second case, the computer must deposit information in the in-out register for the external unit to pick up. The EXTERNAL WRITE instruction (EWjv) performs this operation, by transmitting a word from the memory location or arithmetic register (specified by v) to IOA or IOB (specified by j).

By means of these in-out instructions and registers, the Univac Scientific can communicate with external equipment at rates up to about 25,000 words per second.

Automatic Repeat

In a real-time system, it is important that a computer make efficient use of operating time and storage capacity. The Univac Scientific has an unusual logical feature through which it is possible to realize a sizable reduction in the time spent referring to storage for instructions, and in the storage space devoted to holding instructions. This feature is the REPEAT instruction, by which long sequences of operations can be governed by only two or three instructional references to storage.

THE REPEAT instruction (RPjnw) causes the next following instruction in the program to be executed n times, after which memory address w is consulted for the next instruction. The u and v addresses within the *repeated* instruction may be advanced by one each time. In other words, the repeated instruction may be caused to operate successively on consecutive sets of operands. The designator j specifies whether both u and v, or either one, or neither one, will be so advanced. The repeated instruction with its advancing execution addresses remains in the program control registers during the repetition. The memory location at which the repeated instruction is stored is consulted only once, at the start.

Most of the instructions in the repertory of the Univac Scientific are designed to have significance when used with the REPEAT. The practical result is that, by writing simply a pair of instructions (the REPEAT followed by another instruction), we in effect write a special instruction which directs the high-speed execution of a *series* of operations.

Block Transfer

Let us illustrate this point. The instruction TRANSMIT POSITIVE (TPuv) causes the word at address u to be copied at address v. If we set up a simple two-instruction routine—RP(011)nw—TPu_1v_1—we effect a block transfer of n words from registers u_1 through u_n to registers v_1 through v_n. If the transmissions are within high-speed storage, or between magnetic-drum and high-speed storage, the transfer rate is better than 30,000 *words* per second.

Scalar Product

Consider now the accumulation of products. The instruction MULTIPLY ADD (MAuv) causes the product of the numbers located at u and v to be added to the number already in the accumulator, leaving the full result in the 72-bit accumulator. If we cause MULTIPLY ADD to be repeated—RP(011)nw—MAu_1v_1—we generate the scalar product of two n-vectors. If the numbers are all in high-speed storage, the accumulation proceeds at approximately 3000 products per second.

This ability to form scalar products at a rapid rate, together with other manipulative features of the machine's logic, give it a correspondingly high speed in the multiplication of matrices. This suggests that real-time problems involving simultaneous equations might be effectively handled by matrix inversion techniques.

Linear Smoothing

We have seen how the REPEAT instruction leads to the high-speed accumulation of products and the high-speed transfer of a block of words. Let us now examine how these two compound operations can be applied to linear smoothing, a process common to many real-time control problems.

Suppose it is desired to compute a function y(T) which is expressed as a linear combination of the several recently sampled values of a variable x. Let us consider only the current value and the five preceding values of x, sampled at known fixed intervals of time. Our routine becomes RP(011)(6)w—MAu_1v_1 to compute the value, and RP(011)(6)w—TPu_2v_1 to update the sample.

The w's (the constants of the weighting sequence) are stored at 6 consecutive addresses (u_1 through u_6), and the values of x are stored in 6 consecutive addresses (v_1 through v_6) in reverse chronological order. The computation of the function is simply the formation of a scalar product through the use of a repeated MULTIPLY ADD instruction. The reverse order of addressing has no effect on the scalar product computation, but is helpful in updating the x's for the next computation of y. We must replace the former current value of x with the incoming new value (which has in the meantime been deposited at address v_7) and then move each successively older value of x back by one position.

This is accomplished by programming a regressive form of block transfer, which transmits the word at v_2 to v_1, then v_3 to v_2, and so forth, until finally the new x at v_7 is transmitted to v_6. This process requires only two instructions.

Radix Conversion

In many instances the computer, when a part of a control or data-reduction system, must accept or deliver numbers in decimal form. An effective method for converting decimal to binary numbers makes use of the scalar-product routine. With a pair of instructions— RP (011)nw—MAu_1v_1—we simply accumulate the products of the binary-coded decimal digits of a number by their corresponding powers of ten, expressed in binary form. This again uses merely the REPEAT and MULTIPLY ADD instructions. A 10-digit decimal number is converted to binary numbers by this method in about 2.6 milliseconds.

The reverse conversion, from binary to decimal, is accomplished with a repeated division, RP(011)nw—DVu_1v_1. The DIVIDE instruction (DVuv) causes the number in the 72-bit accumulator to be divided by the number at address u. The binary numbers to be converted are originally placed in the accumulator. The quotients (the binary-coded decimal digits) are placed in address v, and a positive remainder is left in the accumulator. The DIVIDE instruction is designed so that, if it is preceded by a REpeat instruction, and if descending powers of ten (stored in locations u_1 throught u_n) are brought in as successive divisors of the diminishing remainder, then the series of quotients are the binary-coded digits of the decimal representation of the number originally stored in the accumulator. These quotients are deposited at a consecutive series of addresses. A 10-digit decimal number is produced by this pair of instructions in about 5.4 milliseconds.

Cyclic Routines

The foregoing discussion has dwelt largely on the REPEAT instruction, which directs the repeated execution of a single two-address instruction. The question is frequently asked, "How does one handle the cyclic repetition of a routine consisting of a number of instructions?"

The usual process for traversing a repetitive loop a predetermined number of times is to set up a counting index and then, after each iteration of the loop, subtract one from this index, and then test it for zero. In the Univac Scientific, an instruction called the INDEX JUMP compresses into one instruction the reference to the stored index, the subtraction, the test, and the storing of the new value of the index. Written IJuv, is subtracts one from the number at u, returns the result to v, tests to see if the number has turned negative. If not, the loop is reentered by jump to v; if it has, the program continues to the next successive instruction.

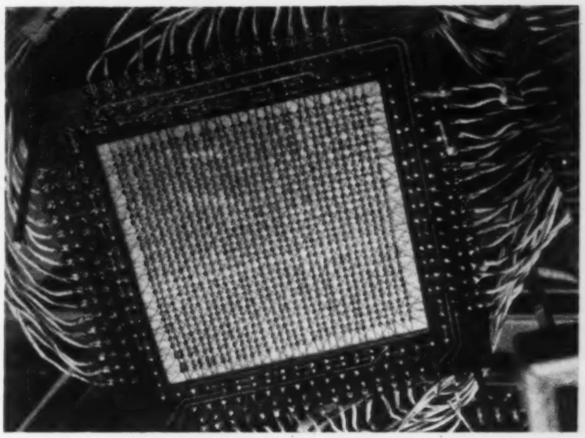


Fig. 13. New magnetic-core high-speed storage element for the UNIVAC Scientific and UNIVAC II features 1024 cores on one plane. Any core can be selected by energizing one of the 32 vertical leads and one of the 32 horizontal leads in the matrix.

Self Checking

We are asked frequently whether or not self-checking is a requirement for real-time applications. Field experience to date leads us to believe that, for the commercial, off-line applications familiar to business data-processing, self-checking is essential. However, in real-time work, self-checking can not be tolerated because an inherent feature of self-checking is that all computation stop at the instant an error is detected. Consider a time-critical process being carried forth under the control of a computer. If the control were relinquished when the computer momentarily malfunctioned, the result could be disastrous.

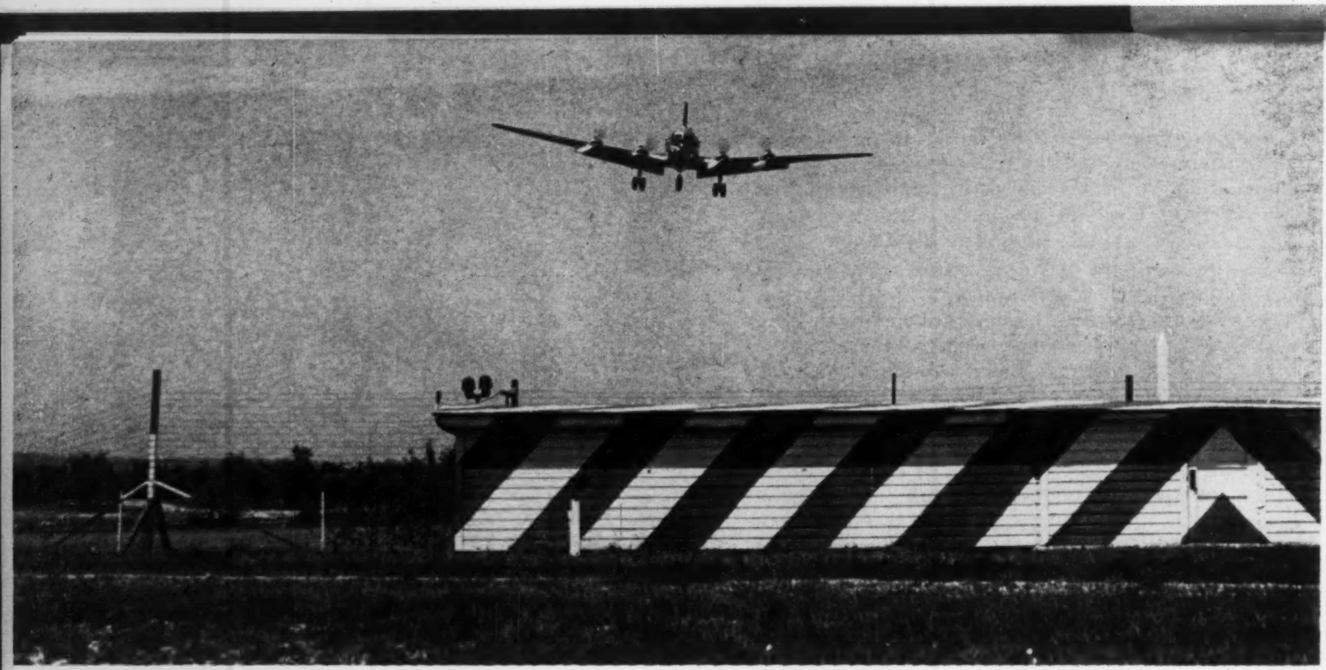
In lieu of self-checking, one must rely on the storage of, shall we say, "tables of tolerable limits." These tables will contain extreme limits within which computations and readings must fall. Critical readings and computations must be constantly compared with the tables as a means of detecting machine errors. Naturally, storage of these tables requires that the real-time computer have a large and easily referenced internal memory. The Univac Scientific, as we have seen, has these features.

Properly used, the Univac Scientific can be adapted to almost any major processing operation involving large-scale manipulations of information, working with external instrumentation or control apparatus. It can be used as the central control for many complex physical systems in real-time, on-line work.

UNIVAC II

The new Remington Rand Univac II magnetic-core electronic computer is a powerful business computer, with double the speed and capacity of the Univac.

Univac II does not use magnetic-drum or acoustic delay-line memory; it relies on the new magnetic-core memory (Fig. 13). The expanded 24,000-character high-speed magnetic-core memory is designed so that, at the user's option it can be supplemented with additional cores to hold 120,000 characters. With the magnetic core, the Univac II can execute instructions at the rate of 8,000 per second.



Instrument Landing System ground transmitters (in low building) transmit radio beams which guide pilot to a safe landing, even under low ceilings and visibility.

AIR TRAFFIC CONTROL

BASICALLY, we have two big problems—first, a decreasing amount of available airspace and second, an ever increasing amount of air traffic. This double problem makes for the classic vicious circle.

THE AIRSPACE PROBLEM

CAA standards for instrument-flight-rules weather require 10 minutes' separation between aircraft operating at the same altitude. Add to that the 1,000 feet of vertical separation required between levels of flight and you can readily see how much airspace is used up in the operation of 70,000 miles of low-frequency airways and approximately an equal amount of VHF airways.

Clamor for reserved airspace comes from many sources—the military services require large blocks for air and ground gunnery; there are restricted and prohibited areas over atomic plants and atomic testing grounds; tall television and radio towers have been erected; flying is prohibited over a large section of downtown Washington. There are now some 450 restricted areas.

And last but not least we have jet aircraft. The space-consuming jet penetration and missed-approach procedures tie up large parcels of airspace in terminal areas. . . . The jet problem extends up above the terminal areas to the high altitudes. At 29,000 feet and above, vertical separation of 2,000 feet is required while still maintaining the 10-minute horizontal separation. This has the effect of reducing the amount of available airspace above 29,000 feet by one-half.

These are the airspace problems. What are we doing to solve them?

Airspace Panel

The Washington Airspace Panel of the Air Coordinating Committee . . . has done a tremendous job in conserving our airspace. We will continue to look to it for sound recommendations.

Rapcon

Also on the positive side is the RAPCON, or Radar Approach Control Center program, operated jointly by the Air Force and the CAA. This coöperative venture in traffic control permits a sharing of the airspace at locations where there is a heavy concentration of traffic brought about by proximity of a civilian terminal and an Air Force installation.

A standard RAPCON installation consists of three surveillance and two precision approach radar units. Under the program the CAA operates the surveillance radar units while the Air Force operates the precision approach radar for actual landings at military bases under instrument-flight-rules conditions. Generally, the landing aids at civil airports in the RAPCON areas are Instrument Landing System installations.

The RAPCON program has been very successful to date. There are now three such centers in operation out of the 18 which eventually will be in use.

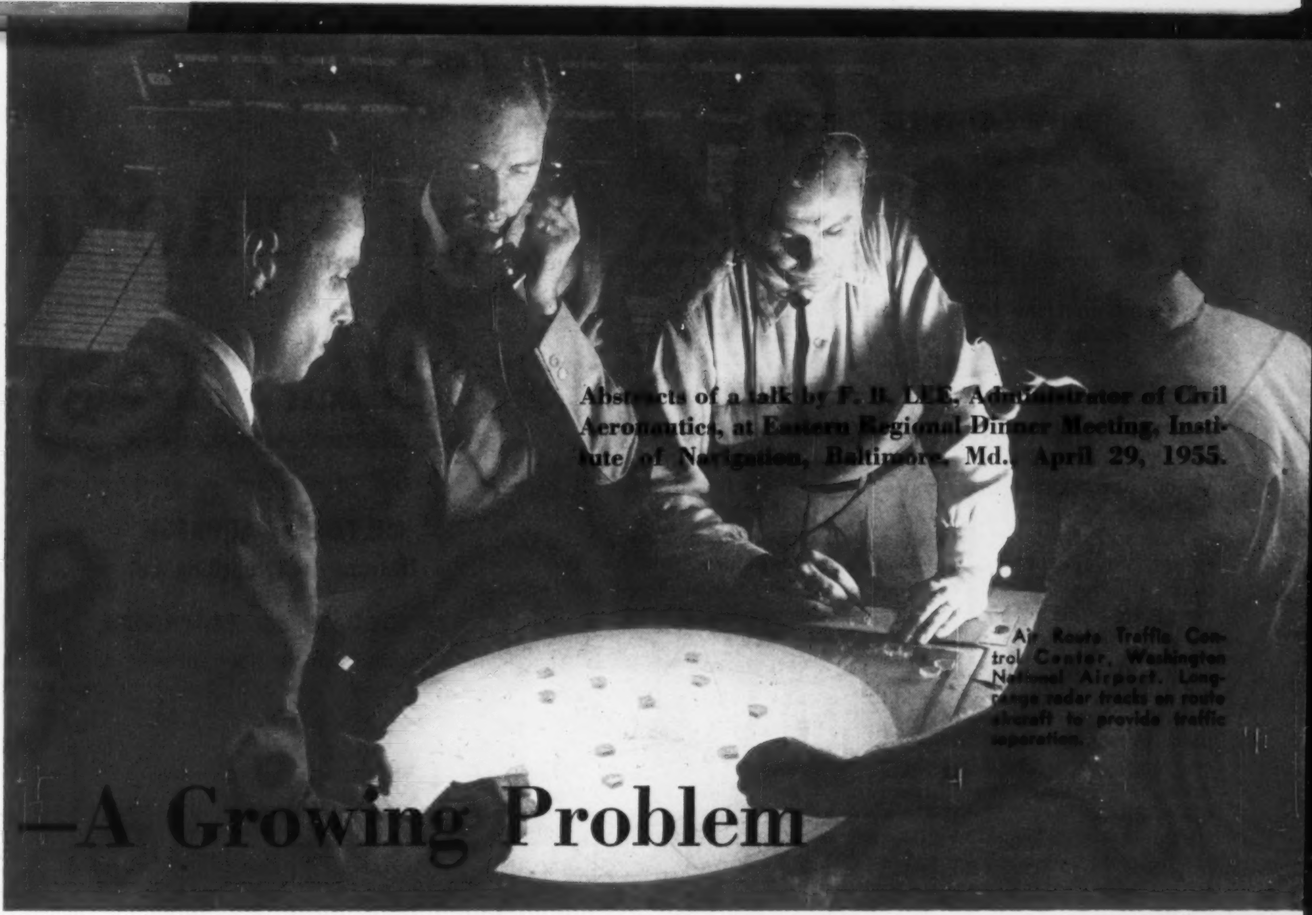
Radar Air Traffic Control Center

I can report, also, that the CAA and the Navy Department have held preliminary talks regarding the establishment of a similar program between the two agencies. The Navy version of the RAPCON program is known as Radar Air Traffic Control Center. They will serve fundamentally the same purpose as the RAPCONS, that of permitting more effective use of airspace.

No decisions have been made as to how we shall control the airspace over the 25,000 foot level. The problem still is in the study stage and we are searching for realistic, practical solutions. One of the problems which must be solved in employing this type of control would be the method of presenting the required information on our air route traffic control centers. The old standard flight data strip, which has been the backbone of en route control for many years, might have to be changed. It may be that we shall have to go to panoramic-type displays.

—A Growing Problem

Abstracts of a talk by F. B. LEE, Administrator of Civil Aeronautics, at Eastern Regional Dinner Meeting, Institute of Navigation, Baltimore, Md., April 29, 1955.



Air Route Traffic Control Center, Washington National Airport. Long-range radar tracks en route aircraft to provide traffic separation.

AIR TRAFFIC PROBLEMS

Unlike airspace, air traffic is tangible and concrete. We can deal with it if we have the proper tools . . . the over-all problem is controlling air traffic safely and smoothly along the airways and into terminal areas.

The volume of traffic along the airways is best presented by the number of fix postings (position reports of en route aircraft).

In 1948 the CAA Air Traffic Control Centers handled approximately 8.5 million fix postings. The year 1951 showed an increase in fix postings up to 11.8 million, and it jumped to 16.8 million in 1954, an increase of 12 percent over the 1953 figure. The year 1954 represents an average of 46,000 fix postings in every 24-hour period in our 27 continental and four territorial Centers.

Just a year ago the CAA predicted that the fix postings would number 24 million by 1960. This would be almost double the 1952 total. We have looked a little further into the future and have come up with a yet unpublished prediction of 28 million fix postings by 1965.

Control Tower Problem

The increase in fix postings during the past year is, of course, reflected in the figures for traffic handled at terminal areas, one of the trouble spots in our air traffic control picture. CAA air traffic control towers handled 17.9 million aircraft movements during 1954. This was an increase of 1.1 million over 1953, or a seven percent gain.

Danger signals have appeared to impress upon us the need for new equipment and improved techniques. The most recent and ominous appeared in New York area on September 15, 16, 17, 1954. It will be a long time before the traffic controllers in the three major airports in the New York area forget those three days. They refer to the whole period as "Black Friday." At one point, for nearly an hour we were not accepting any flight plans whatsoever. Inbound delays were running up to 90 minutes at La Guardia. Outbound delays ran up to one hour, 53 minutes at Newark. Idlewild was in no better shape. This all took place while our controllers racked up an all time record for IFR operations for one day in the New York area.

The delays around New York during those three days were felt far to the North, South, and West. We believe we now have the New York situation well in hand. The Air Force generously made available a radar with a range of 100 miles. We strengthened our controller force and put in additional flight progress boards and more channels for direct communications from the Center to pilots in the area.

We are in the process of establishing a new Air Route Traffic Control Center at Idlewild where we will have a permanent long-range radar of our own. This new Center should be ready for operation some time this year.

We are in the process of taking further steps to correct the situation at New York. After intensive study, we have decided to install another Instrument Landing System at Idlewild Airport. When installed, it will make the first time that two ILS systems have served the same airport.

What happened in New York can happen elsewhere. In order to reach solutions before the situation becomes acute in any area, we have successfully used the Dynamic Air Traffic Control Simulator at our Technical Development and Evaluation Center at Indianapolis. By use of the device, which is a joint project of the CAA and the Air Navigation Development Board, it now is possible to project and solve the traffic problem at any location right in our Indianapolis laboratory using experienced air traffic controllers and pilots of simulated aircraft.

We in CAA believe one of the solutions to the en route traffic problem would be in the use by CAA controllers of existing military air defense radar . . . we now are conducting a study to determine how best to provide full radar coverage for en route traffic between the heavily congested areas between Norfolk and Boston, and New York and Chicago.

ELECTRONIC

CHARLES F. KEZER
Potter Instrument Co.

and

MILTON H. ARONSON
Instruments Publishing Co.

DIVIDE-BY-THREE CIRCUIT

Pulse feedback is used to make two flip-flops divide by three (instead of four) in this circuit. When the third input pulse is received, the second flip-flop feeds a pulse back to the first; thus one of the four conditions is skipped. Neon indicators I1 and I2 indicate the flip-flop condition.

Suppose that the left-hand halves of both tubes are initially conducting, with both neons lit (we refer to this as the "on" condition for the flip-flops).

1. First input pulse turns V1 off; output from V1 turns V2 off.
2. Second input pulse turns V1 on; V2 remains off.
3. Third input pulse initially turns V1 off, bringing V2 on, but negative-going pulse fed back via R1-C1 immediately turns V1 back on.

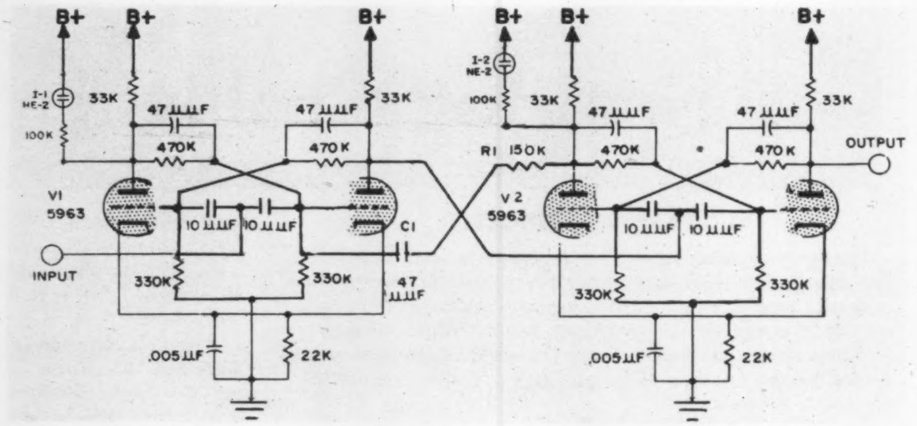
Thus in three input pulses the original condition is restored, and the process may continue indefinitely. Additional flip-flops may be cascaded with the scale-of-three circuit to divide by six or twelve. Similar techniques may be used for other ratios—for example, to divide by seven using three flip-flops (see next circuit). Circuits are available in plug-in form from supplier.

Input Signal: 80 v negative pulse or square wave, frequency range 0-40 kc. Minimum duration: 7 usec. Rise time: 0.5 to 3 usec.

Output: Amplitude: 100 v no load, 93 v maximum load. Rise time: positive-going, 8 usec; negative-going, 2 usec.

B supply: 200 v dc at 7 ma.

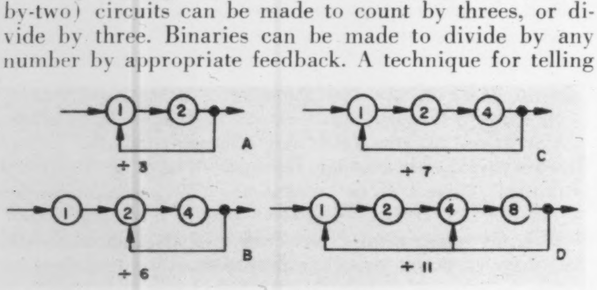
Source: EECo Production Co., 827 S. Vermont Ave., Los Angeles, Calif.



Divide-by-three circuit →

DIVIDING WITH BINARIES

The preceding circuit shows how two binaries (count-by-two) circuits can be made to count by threes, or divide by three. Binaries can be made to divide by any number by appropriate feedback. A technique for telling



exactly what end count will be with any circuit is to write the numbers 1, 2, 4, 8, . . . in the schematic and subtract the numbers to which feedback is applied from total count.

In example A, two binaries without feedback count by 4's. Subtract 1 from 4 and result is a count-by-3 circuit.

In example B, 3 binaries without feedback count by 8. Subtract 2 from 8; thus the circuit is a count-by-6.

In example C, the 3 binaries would count by 8 without feedback. Subtract 1 from 8; therefore, the circuit is a count-by-7 circuit.

In example D, the four binaries would count by 16 without feedback. With feedback as shown, subtract 5 from 16, and circuit divides by 11.

TRANSISTOR VOLTAGE AMPLIFIER

Low input-impedance and high output-impedance characteristics of transistors often are obstacles to their use as voltage amplifiers. One approach is transformer coupling. In this circuit, however, negative feedback is used to increase input impedance and to lower output impedance to levels comparable with those obtained from a dual-triode tube. Feedback also increases circuit stability. Two type 2521 transistors provide a voltage gain of 15 at audio frequencies. Primary of a high-impedance transformer was used for the audio choke shown. Power consumption of amplifier is less than one tenth that of a comparable dual-triode vacuum-tube amplifier using subminiature type 6112.

Voltage gain: 15.

Input impedance: 450,000 ohms.

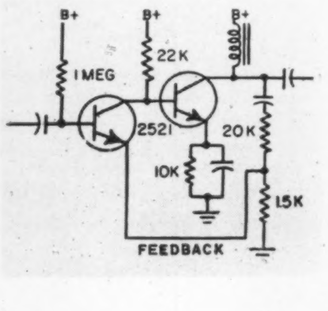
Output impedance: 550 ohms.

Output voltage: 3 v rms.

Load resistance: 400,000 ohms or higher.

B supply: 30 v dc at 5 ma.

Source: Stanley Shenkerman, W. L. Maxson Corp., N. Y., in *Electronics*, Nov., 1954.

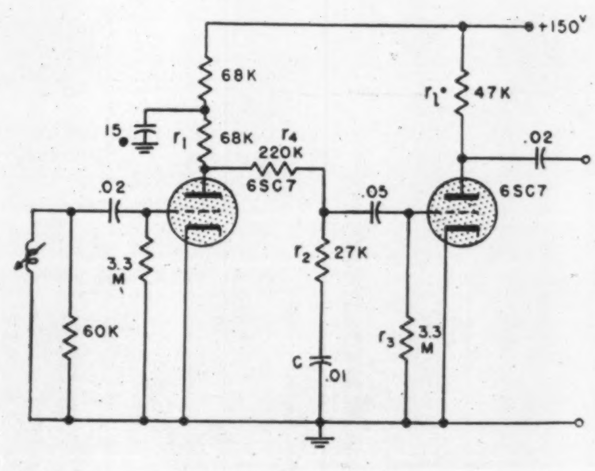


CIRCUITRY

The circuit is the heart of all electronics. Here are six more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

MINIATURE OSCILLOSCOPE

Scope tube, positioning controls, intensity controls and resistor divider string have been built into a package requiring no more panel space than a standard panel meter using this simple circuit. One-inch-diameter 1CP1 cathode-ray tube (Cossor) requires no focus control. Frequency response depends on external amplifiers. Unit is Model 90901 oscilloscope of manufacturer.



+150ᵛ
68K
15
r₁
68K
r₄
220K
6SC7
r₁'
47K
.02
.02
.05
6SC7
3.3 M
r₂
27K
60K
C
.01
r₃
3.3 M

A Supply: 6.3 v at 0.6 a.

B Supply: 600 to 900 v dc at 3.2 ma.

Sensitivity: Vertical, 4.7 v per mm; horizontal, 6.9 v per mm.

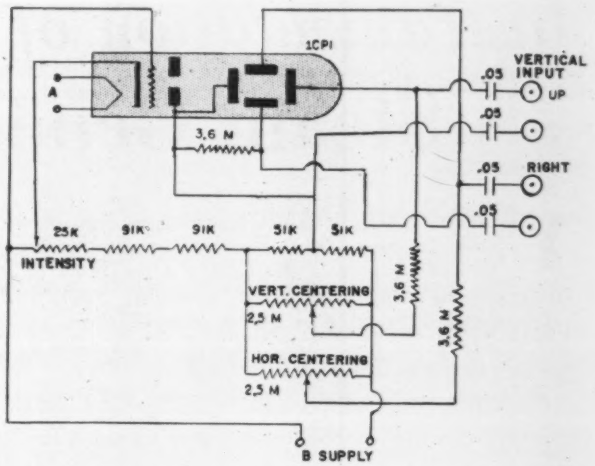
Source: James Millen Mfg. Co., Malden 48, Mass.

VARIABLE-RELUCTANCE-PICKUP PREAMP

This preamplifier boosts the output of a variable-reluctance phonograph pickup to the level required to drive the usual power amplifier, and provides the low-frequency equalization required to compensate for the recording characteristic. Equalization (18 db down at 800 cps relative to 50 cps) is provided by network R4-R2-C. The 60,000-ohm resistor across the pickup is the value required by one popular type of pickup for proper high frequency response. Cost was evidently a prime consideration in the design of this circuit: cathode resistors and the heavy bypass capacitors that would be required have been eliminated; grid bias is obtained by grid current in the 3.3-megohm grid resistors.

Input signal: 10 millivolts

Output level: 1 volt



1CP1
A
3,6 M
.05
VERTICAL INPUT
UP
.05
.05
RIGHT
.05
25K
91K
91K
51K
51K
INTENSITY
VERT. CENTERING
2,5 M
HOR. CENTERING
2,5 M
3,6 M
3,6 M
B SUPPLY

Gain: 40 db

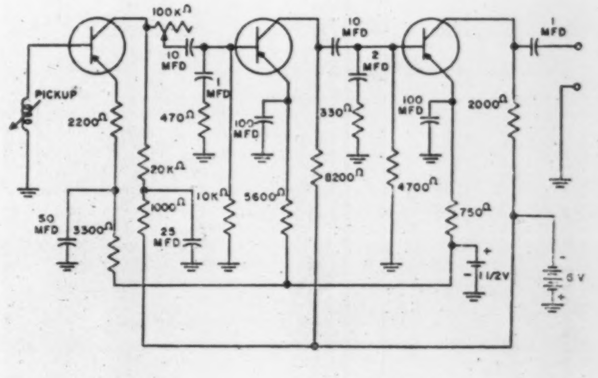
Noise Factor: 50 db at 50 cps.

B Supply: 150 v at 12 ma (2 watts)

Source: R. F. Shea, *Electrical Engineering*, April, 1954.

TRANSISTORIZED PREAMP

A comparison of transistors and tubes performing same function is of great current interest. A tube has nearly infinite current (or power) amplification, but a voltage gain of about 50 (for triodes) or 200 (for pentodes); a transistor has current gain of about unity (grounded-base amplifier) or 50 (grounded-emitter amplifier)—but a voltage gain that can exceed 2000. Other basic differences: tube input resistance is megohms, transistor is 50 ohms (grounded base) or 1000 (grounded emitter). Output resistance of tube is 10,000 to 50,000 ohms; 20,000 to 2,000,000 for transistors.



100KΩ
10 MFD
10 MFD
2 MFD
1 MFD
1 MFD
PICKUP
2200Ω
470Ω
100 MFD
330Ω
100 MFD
2000Ω
20KΩ
1000Ω
25 MFD
10KΩ
5600Ω
8200Ω
4700Ω
750Ω
50 MFD
3300Ω
1 1/2V
6V

General Electric 2N43 p-n-p transistors are used to produce this circuit with the same frequency-response specifications as the circuit preceding this one. This permits a direct comparison of circuits as to components required. The lower impedance of transistor input and output necessitates use of larger-valued capacitors, and use of two compensating networks to effect same frequency-response compensation. Note that power requirements for this circuit is only 15 mw, compared to 2000 mw for tube circuit, not including heater power.

Input resistance: 60,000 ohms

Over-all gain: 60 db (factor of 1000),

Undistorted output: 2 milliwatts

Power required: 15 milliwatts

Signal to noise factor: 50 db at 50 cps

Source: R. F. Shea, *Electrical Engineering*, April 1954.

Instrumentation of a Modern Steam Generating Facility

YOUNGSTOWN DISTRICT, which is comprised of both the Ohio Steel Works and the McDonald Mills, is a part of the Central Operations of the United States Steel Corporation. The Ohio Steel Works supplies semi-finished steel in the form of slabs, billets, and blooms to the McDonald Mills, about six miles away, for finishing into bar and strip products.

All power for the district is generated at 25 cycles in the Ohio Works Power House. This power is transmitted over high-tension lines to the electrified McDonald finishing mills, and distributed to the general Ohio Works system for auxiliary drive requirements.

In August, 1953, a new 15,000-kw topping turbo generator was put into operation to replace seven blast-furnace-gas-powered engines having a total rated capacity of 17,200 kw. Two of these gas-powered engines were replaced in 1949 by two 2,500-kw frequency changers to convert purchased 60-cycle power to 25 cycles. The new

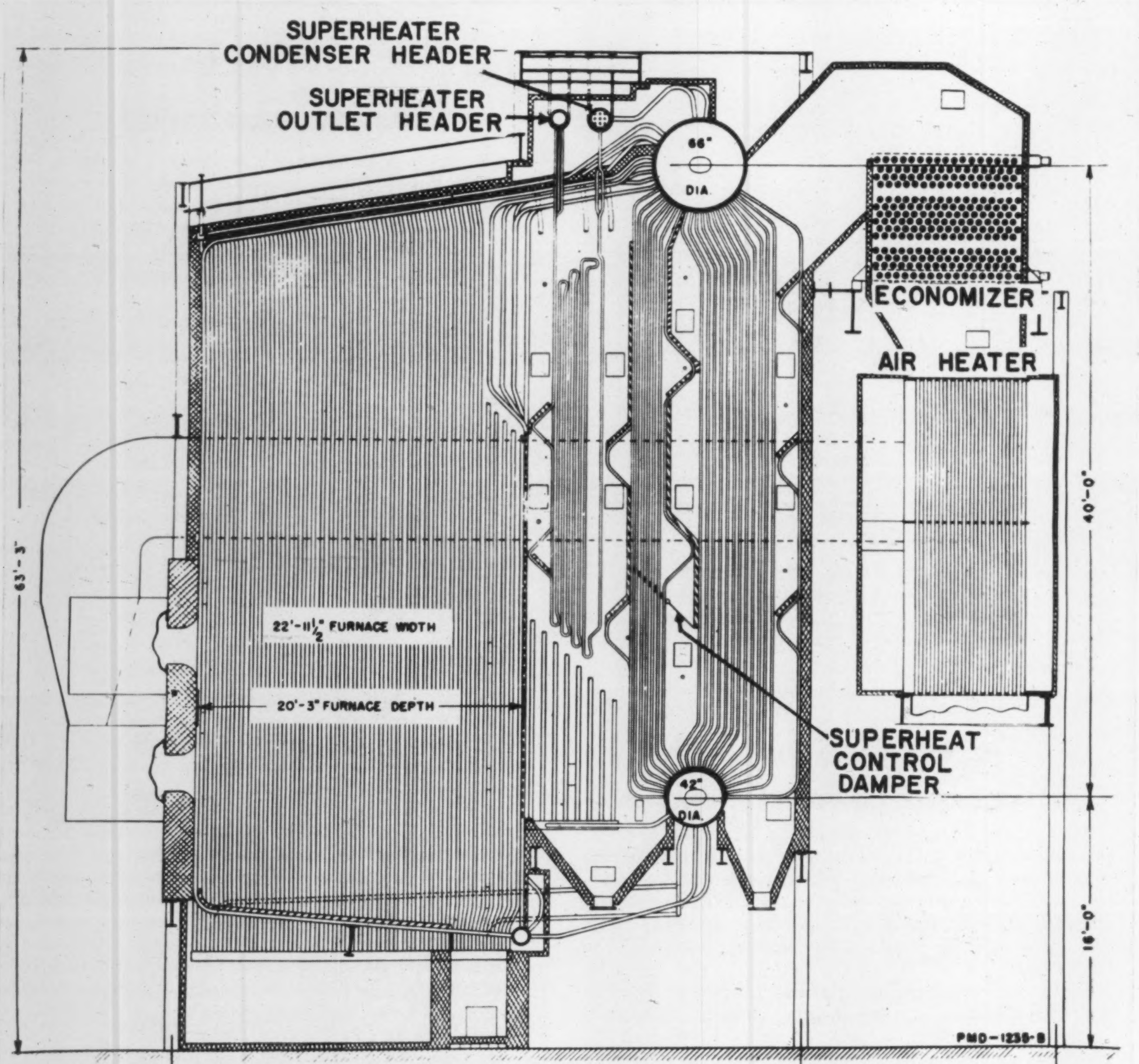

SUPERHEATER CONDENSER HEADER
SUPERHEATER OUTLET HEADER
66" DIA.
ECONOMIZER
AIR HEATER
63'-3"
40'-0"
22'-11½" FURNACE WIDTH
20'-3" FURNACE DEPTH
SUPERHEAT CONTROL DAMPER
42" DIA.
16'-0"
PMD-1235-B
39'-0"
16'-2"

Fig. 1. Cross section of new blast-furnace-gas-fired boiler with capacity of 250,000 lb/hr, supplying steam at 900 psig and 900 deg F.T.T. (Courtesy Foster Wheeling Corp.)

Presented at Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, March 25, 1954.

Two new blast-furnace-gas-fired boilers with capacity of 250,000 lb/hr each, supplying steam at 900 psig and 900 deg F were put in operation in 1953. Here is a complete résumé of the boiler system and its instrumentation.

J. P. KATZENMEYER

U. S. Steel Corp.

15,000-kw topping turbo generator, along with two 15,000-kw condensing turbo generators (installed in 1926) gives the district a total rated 25-cycle generating-capacity of 45,000 kw plus a stand-by frequency-changer capacity of 5,000 kw (supplied by a public-utility connection that also supplies about 3,000 kw of 60-cycle power).

Steam Generating Units

Two new 950-psig 900-deg-F blast-furnace-gas-fired boilers, with a rated capacity of 250,000 lb/hr each, were put into operation in July and August, 1953, to supply steam at 900 psig and 900 deg F.T.T. to the throttle of the new topping turbo generator. This boiler house, to be known as No. 10 Boiler House, in combination with the new topping turbo generator, made it possible to achieve low power costs for the plant, while utilizing the maximum amount of blast-furnace gas available, and permitting the abandonment of a boiler house consisting of six underfeed-stoker-fired boilers.

The two new boilers are identical (Fig. 1) and each has a predicted performance indicated in Table 1. Note

Table 1.—Predicted Performance of New Boiler with Various Fuels. (Courtesy Foster Wheeling Corp.)

	Blast-Furnace Gas			*Oil*	*Natural Gas*
Steam Generated (lb/hr)	165,000	250,000	275,000	275,000	275,000
Steam Pressure (psig)					
Boiler drum	963	979	985	985	985
Superheater outlet	950	950	950	950	950
Temperatures (degrees F)					
Steam at superheater outlet	900	900	900	900	900
Feed water entering unit	220	220	220	220	220
Feed water leaving economizer	385	431	430	351	347
Air entering unit	80	80	80	80	80
Air leaving air heater	390	446	455	308	311
Gas leaving furnace	1,695	1,835	1,870	2,125	2,090
Gas leaving boiler	769	865	884	811	798
Gas leaving economizer	502	590	608	504	503
Gas leaving air heater	387	452	469	328	331
Excess air at air heater exit (percent)	30	30	30	24	18
Wet gas at air heater exit (lb/hr)	421,000	662,000	732,000	400,000	390,000
Air weight entering unit (lb/hr)	168,000	265,000	293,000	341,000	335,000
Drafts (inches H_2O)					
In furnace	.10	.10	.10	.10	.10
Loss thru boiler	1.00	2.33	2.88	.86	.85
Loss thru superheater	.25	.58	.70	.50	.50
Loss thru economizer	1.13	2.39	2.85	.95	.89
Loss thru air heater	.54	1.39	1.75	.41	.41
Loss thru flues	.13	.32	.41	.13	.12
Total draft loss	3.15	7.11	8.69	2.95	2.87
Air Pressure (inches H_2O)					
Loss thru air heater	.94	2.20	2.75	3.3	3.3
Loss thru ducts	.47	1.20	1.50	2.3	2.2
In wind box	1.80	4.10	4.90	5.5	5.4
Total air pressure	3.21	7.50	9.15	11.1	10.9
Fuel					
Burned (cfm)	48,800	76,100	84,200		
Burned (lb/hr)				22,000	19,250
Calorific Value (BTU/cu ft)	86.9	86.9	86.9		
Calorific Value (BTU/lb)				18,550	22,150
Liberation (BTU/hr/cu ft total volume)	12,380	19,250	21,350	19,850	20,750
Heat Losses (percent)					
Dry Gas	12.0	14.6	15.2	5.5	4.9
Hydrogen & Moisture in fuel	2.5	2.5	2.5	6.4	10.8
Moisture in air	.3	.3	.4	.2	.2
Radiation	1.0	.5	.5	.5	.5
Unaccounted for	1.5	1.5	1.5	1.5	1.5
Total losses	17.3	19.4	20.1	14.1	17.9
Efficiency (percent)	82.7	80.6	79.9	85.9	82.1

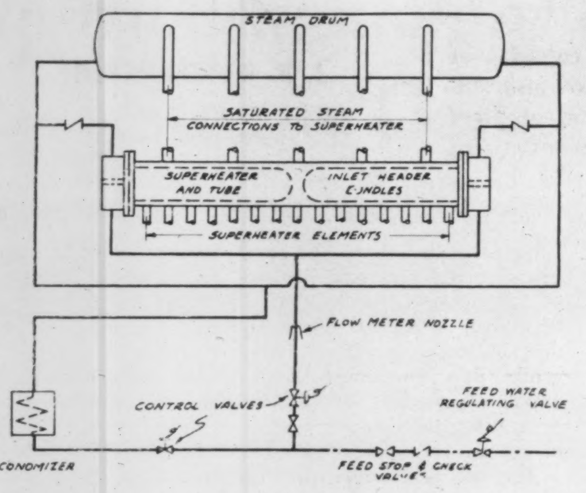


Fig. 2. Steam temperature control. (Courtesy Bailey Meter Co.)

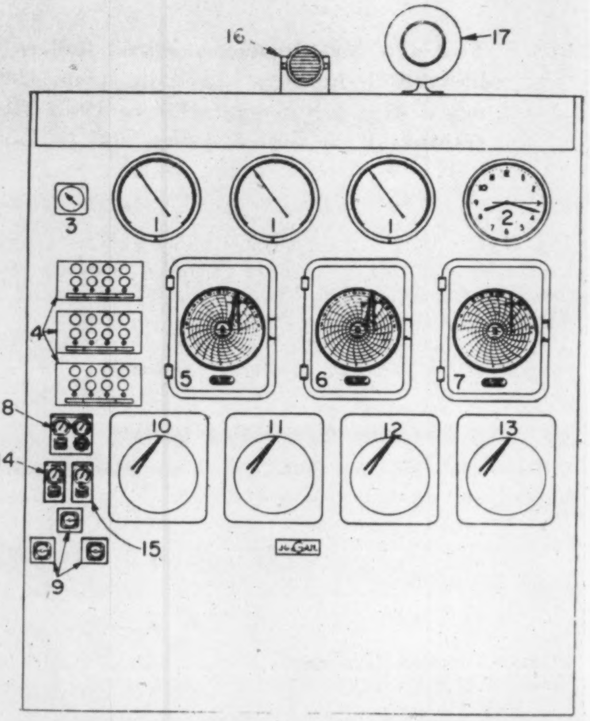


Fig. 3. Master panel. Units (1) are pressure gages for high-pressure header, plant steam header, and feed water header. Units (4) are annunciators. Unit (5) is natural-gas flow and pressure recorder. Unit (13) is blast-furnace-gas pressure and temperature recorder. Units (6 and 7) are plant and auxiliary steam flows. Unit (8) is master relay. Units (16 and 17) are horn and siren.

Table 2.—Heating Surfaces and Furnace Volume

Boiler	18,000 sq ft
Water Walls	8,750 sq ft
Superheater (Conv.)	5,800 sq ft
Economizer	15,700 sq ft
Air Heater	31,600 sq ft
Furnace Volume	20,600 cu ft

that the performance is shown for blast-furnace gas, fuel oil, and natural gas, although blast-furnace gas is the only fuel installed. However, the burners are designed to handle any fuel by adding the necessary parts.

The boiler is a vertical two-drum type with water-cooled walls and a water-cooled furnace bottom. The lower or mud drum is 42 inches in diameter; the upper or steam drum is 66 inches in diameter.

The *steam drum* internals consist of a 4-inch feed pipe, a 1-inch chemical feed pipe, and a 1-inch continuous blowdown pipe. All of these pipes extend the entire length of the drum and have small holes equally spaced for even distribution. Along one side of the drum are 30 horizontal separators, which separate the steam and water entering the drum from the boiler and water wall tubes. The water is discharged down below the water level, and the steam flows to the top of the drum through 13 chevron-type purifiers, and out to the superheater-inlet header.

The *superheater* (Figs. 1 and 2) is a vertical single-pass type consisting of four loops, with provision for a fifth loop. It is suspended from the inlet and outlet headers located above the furnace roof, and it lies in the first pass of the boiler.

There are four *burners*, two upper and two lower. Natural gas is used for the continuously burning pilots. The economizer is a horizontal continuous-loop tubular type with tubes connecting to inlet and outlet headers, and is of the counterflow design.

All heating surfaces are tabulated in Table 2.

Forced-Draft Fans

Each boiler is equipped with one forced-draft fan, which is of the heavy-duty double-inlet backward-curved type. Each fan requires 291 brake horsepower at its rating of 90,000 cfm of air, at 16 inches static pressure, and 1453 rpm with air at 100 deg F.

They are driven by geared steam turbines with a rating of 300 HP at 4,884 rpm. The steam conditions at the throttle are 280 psig and 600 deg F.

Induced-Draft Fans

Each boiler is equipped with one induced-draft fan, which is a heavy-duty type, double-inlet multivane, equipped with inlet vane control. It is driven by geared steam turbines rated at 1,400 hp at 5,473 rpm. The steam conditions and method of governing are the same as for the forced-draft fan drives.

Boiler Feed Pumps

There are three horizontal barrel-type boiler feed pumps with inner and outer casing. Each pump is rated at 800 gpm (approximately 400,000 lb/hr) at 3,100-ft total dynamic head when operating at 3,560 rpm. The pumps are driven by steam turbines rated at 800 hp at 3,600 rpm. The steam conditions at the throttle and method of governing are the same as for the forced-draft fans. Overheating of the pump at low output is prevented by bypassing to the deaerating heater.

Blast-Furnace-Gas Precipitators

Two new single-unit wet tubular-type electrostatic precipitators were installed in parallel to clean primary washed blast-furnace gas before use in the boilers. Each precipitator has a capacity of 90,000 cfm with saturated gas entering at 100 to 130 deg F and 8 to 40 inches static water pressure. The guaranteed efficiency is 93 percent,

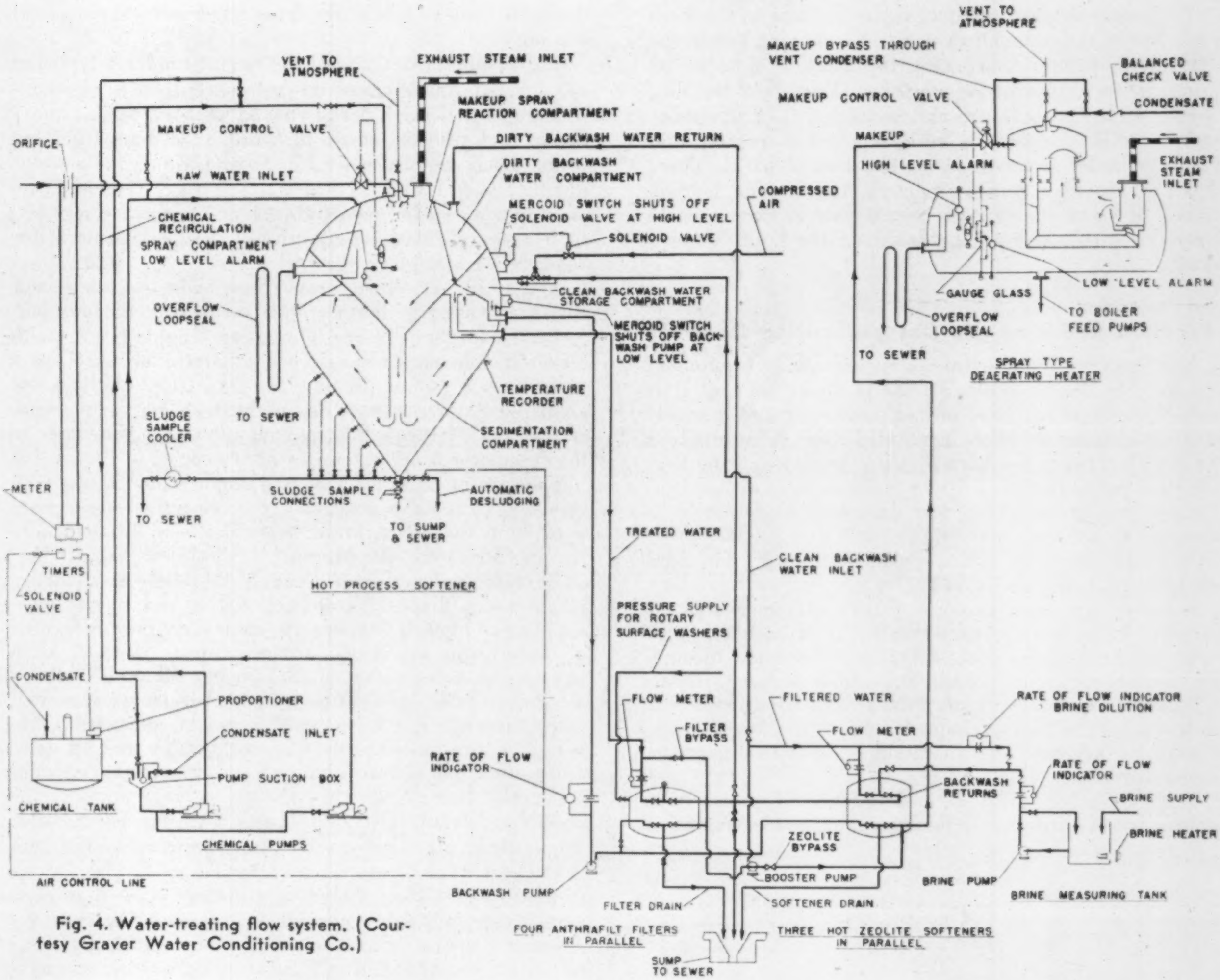

VENT TO ATMOSPHERE
EXHAUST STEAM INLET
MAKEUP SPRAY REACTION COMPARTMENT
ORIFICE
MAKEUP CONTROL VALVE
DIRTY BACKWASH WATER RETURN
RAW WATER INLET
DIRTY BACKWASH WATER COMPARTMENT
COMPRESSED AIR
CHEMICAL RECIRCULATION
MERCOID SWITCH SHUTS OFF SOLENOID VALVE AT HIGH LEVEL
SPRAY COMPARTMENT LOW LEVEL ALARM
SOLENOID VALVE
CLEAN BACKWASH WATER STORAGE COMPARTMENT
OVERFLOW LOOPSEAL
MERCOID SWITCH SHUTS OFF BACKWASH PUMP AT LOW LEVEL
TEMPERATURE RECORDER
SLUDGE SAMPLE COOLER
TO SEWER
SEDIMENTATION COMPARTMENT
METER
SLUDGE SAMPLE CONNECTIONS
AUTOMATIC DESLUDGING
TO SEWER
TO SUMP & SEWER
TREATED WATER
TIMERS
SOLENOID VALVE
HOT PROCESS SOFTENER
CLEAN BACKWASH WATER INLET
PRESSURE SUPPLY FOR ROTARY SURFACE WASHERS
CONDENSATE
PROPORTIONER
CONDENSATE INLET
PUMP SUCTION BOX
CHEMICAL TANK
CHEMICAL PUMPS
AIR CONTROL LINE
RATE OF FLOW INDICATOR
FLOW METER
FILTER BYPASS
FILTERED WATER
FLOW METER
BACKWASH RETURNS
RATE OF FLOW INDICATOR BRINE DILUTION
RATE OF FLOW INDICATOR
BRINE SUPPLY
BRINE HEATER
ZEOLITE BYPASS
BOOSTER PUMP
BACKWASH PUMP
FILTER DRAIN
SOFTENER DRAIN
BRINE PUMP
BRINE MEASURING TANK
FOUR ANTHRAFILT FILTERS IN PARALLEL
THREE HOT ZEOLITE SOFTENERS IN PARALLEL
SUMP TO SEWER
VENT TO ATMOSPHERE
MAKEUP BYPASS THROUGH VENT CONDENSER
BALANCED CHECK VALVE
MAKEUP CONTROL VALVE
CONDENSATE
MAKEUP
EXHAUST STEAM INLET
HIGH LEVEL ALARM
GAUGE GLASS
LOW LEVEL ALARM
OVERFLOW LOOPSEAL
TO BOILER FEED PUMPS
TO SEWER
SPRAY TYPE DEAERATING HEATER

Fig. 4. Water-treating flow system. (Courtesy Graver Water Conditioning Co.)

which leaves about 0.015 grains/cu ft of dust in the blast-furnace gas going to the boilers.

Feedwater Treating System

The feedwater treating system (Fig. 4) consists of a sphericone softener (upper left in Fig. 4), filters, zeolite softeners, and necessary auxiliary equipment.

The sphericone hot-process softener has a capacity of 400,000 lb/hr and provides preliminary heating, deaeration, partial softening, and clarification of the raw water entering the system. From the softener, the water is more completely clarified by four filters arranged in parallel with a capacity of 100,000 lb/hr each. After the filters, complete softening is accomplished by three hot-zeolite softeners arranged in parallel with a capacity of 133,500 lb/hr each.

A deaerating heater is provided for final heating and deaeration of both treated water and condensate.

The raw water used is a local industrial water pumped from a series of lakes and known as Ohio Service Water. City water and river water can be used in an emergency.

Control Air

Control and instrumentation are pneumatic. All compressed air for automatic control systems (except the soot blowers) is taken from an air receiver which normally receives its air from the plant 80-100-psig system. However, an emergency motor-driven air compressor is provided to cut in automatically in event of low plant air pressure. All control air is passed through three "Condensifilters" before going to the several air systems. One filter is used for automatic control air, another is used for soot-blower operating air, and the third is used as a spare for either system. Air pressure reducing valves and additional air filters, either at the control panels or at individual controllers, reduce the air pressure to the desired value as recommended by the manufacturer.

Steam Temperature Control

A steam temperature control (Fig. 2) is provided on each boiler to maintain a minimum variation of steam temperature, thus protecting the new topping turbine against undesirable expansion changes. This control maintains the steam temperature at 900 deg F plus or minus 10 degrees at loads above 165,000 lb/hr. At lower steam loads the temperature control is inoperative, and the steam temperature will drop below 900 F with decrease in load.

Control of steam temperature is accomplished by varying the quality of the steam entering the superheater tubes from the superheater inlet header. The required degree of moisture in the steam is produced by condensing a portion of the saturated steam in the inlet header with a surface-type condenser. At boiler loads above 165,000 lb/hr, a portion of the boiler feed water is by-passed around the economizer and used as cooling water in the condenser so that condenser and economizer are operating in parallel. There are two condensers, one in each end of the inlet header.

Diaphragm-operated control valves, located in the feedwater line to the economizer and in the by-pass line to the condensers, automatically vary the rates of flow as required by the temperature controller. This controller also records steam temperature and is mounted on the boiler control panel. The flow to the condensers is metered and a flow recorder is mounted on the control panel. There also are provided remote manual controls for manual control of the two feed-water control valves. These remote manual controls also are mounted on the boiler control panel.

Pressure Reducing and Desuperheating Control

The Pressure Reducing and Desuperheating Equipment installed in No. 10 Boiler House is shown in Fig. 7. It consists of three identical pressure-reducing and desuperheating systems installed in parallel (one is normally a stand-by) between the high-pressure header and the low-pressure plant system.

Each pressure-reducing and desuperheating system is designed to handle a maximum capacity of 300,000 lb/hr with initial steam at 950 psig and 900 deg F, and final steam at 280 psig and 600 F.

A master pressure regulator (lower left) measures the pressure in the high-pressure header. This regulator provides air loading pressure, which is transmitted through the manual-automatic control sub-panels to the cylinder-type valve operators. With this arrangement, steam is spilled from the high-pressure header to the low-pressure header as necessary to maintain a constant upstream header pressure.

Each reducing valve is a double-seated globe type. Bodies are of chrome-molybdenum steel, grade WC6, and the valve trim is fabricated from hardened stainless-steel forgings.

The desuperheaters are of the steam-atomizing type and are located immediately downstream of each pressure-reducing valve. Each desuperheater uses a constant quantity of high-pressure steam to atomize the desuperheating water. Each desuperheater can handle a maximum water quantity of 40,000 lb/hr water at 150 deg F. The quantity of atomizing steam used by each desuperheater is 8,000 lb/hr, regardless of the quantity of desuperheating water required at any given time.

About 70-feet downstream from each desuperheater there is located a thermocouple measuring the desuperheated steam temperature. This thermocouple is used with an electronic temperature recorder-controller which provides an air output pressure for actuation of the valve controlling water to each desuperheater. This air pressure is transmitted through a manual-automatic sub-panel to the desuperheating water control valve.

Each water control valve is a single-seated globe type operated by a valve positioner receiving the output pressure from the temperature controller, and in turn controlling air to the diaphragm.

In each atomizing steam supply line there is located a single-seated diaphragm shut-off valve, and in each air-supply line to each temperature controller there is located a 3-way snap-action diaphragm valve. Also, in each pressure-reducing-valve cylinder operator there is included a ball-type pilot valve. This equipment is arranged so that when the reducing valve reaches its closed position, 15-psi air is transmitted to the atomizing steam shut-off valve and to the snap-action valve in the temperature-controller air-supply line. When this air pressure is applied, the atomizing steam valve closes, and the snap-action valve shuts off the air supply to the temperature controller and, at the same time, opens the loading line to the water valve to atmosphere. Thus, when the pressure in the high-pressure system falls below normal, each reducing valve under automatic operation closes and then automatically shuts off the atomizing steam and the air supply to the temperature controller. This causes a complete shut-down of the

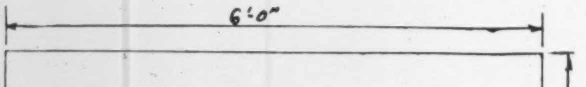


Fig. 5. Pressure-reducing and desuperheating control panel. Instruments are as follows: (300) is 950-psi-header press. gage; (301) is 280-psi-header gage; (302) is desuperheating-water press. gage; (303, 304, and 305) are steam-temp. recorder-controllers and pressure recorders; (306-311) are manual-automatic selector valves for the pressure and temperature controllers no. 1, 2, and 3.

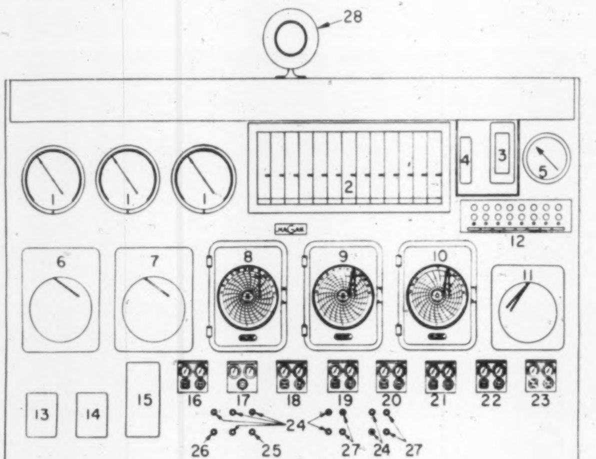


Fig. 6. Boiler panel. Units (1) are pressure gages for superheater outlet, boiler drum, and feedwater. Units (2) are 13-pointer draft gages for air at burners, blast-furnace gas at burners, etc. Unit (8) is steam-air flow recorder. (9) is blast-furnace-gas flow recorder. (10) is feedwater flow and level. (16) is boiler relay. (17) is ratio relay. (27) is burner flame failure switch. Others are fan control stations, etc.

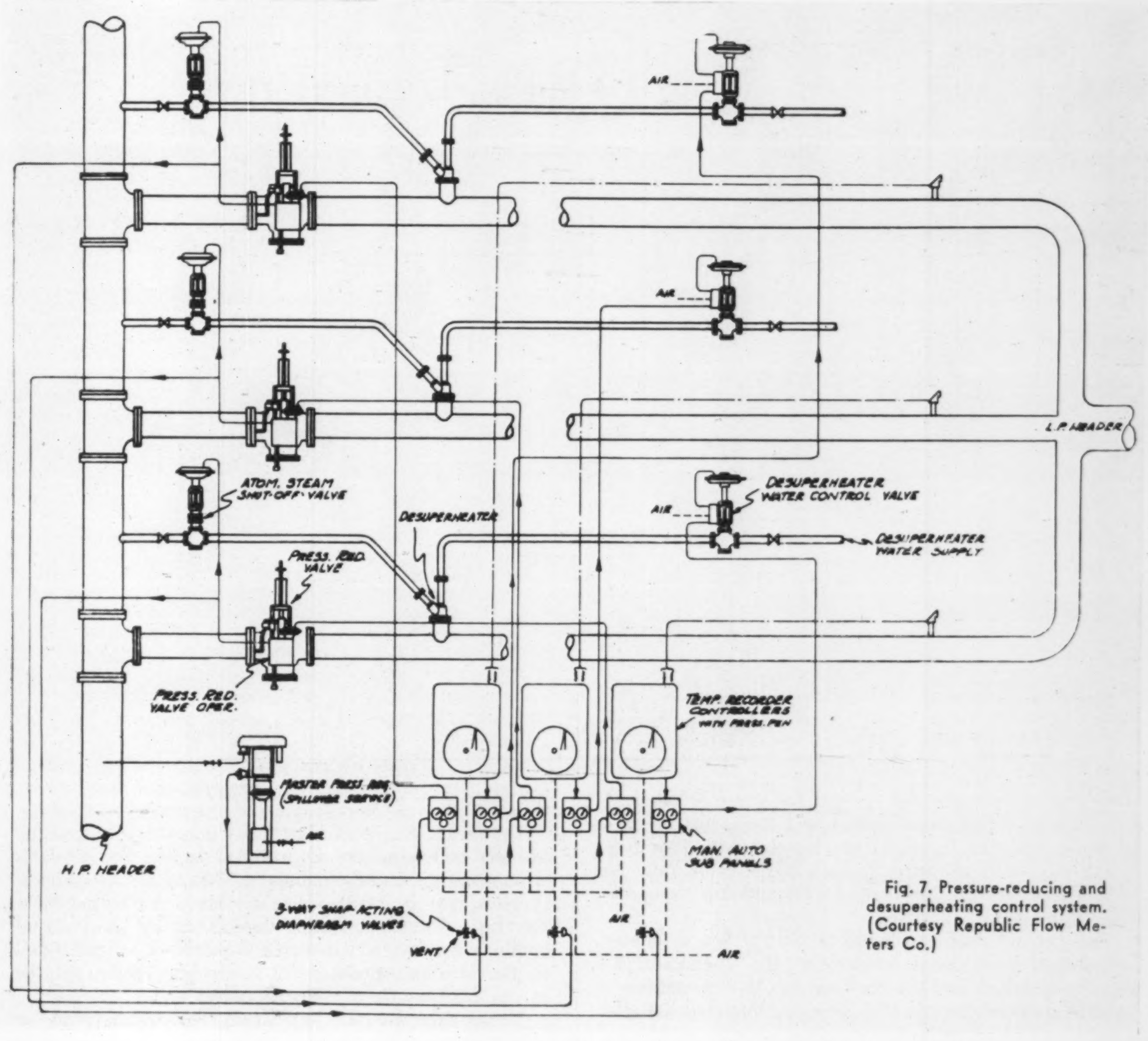

AIR
AIR
ATOM. STEAM
SHUT-OFF VALVE
DESUPERHEATER
PRESS. RED.
VALVE
PRESS. RED.
VALVE OPER.
AIR
DESUPERHEATER
WATER CONTROL VALVE
DESUPERHEATER
WATER SUPPLY
L.P. HEADER
TEMP. RECORDER
CONTROLLERS
WITH PRESS. PEN
MASTER PRESS. REG.
(SPILLOVER SERVICE)
AIR
MAN. AUTO
SUB PANELS
H.P. HEADER
3-WAY SNAP-ACTING
DIAPHRAGM VALVES
VENT
AIR
AIR

Fig. 7. Pressure-reducing and desuperheating control system. (Courtesy Republic Flow Meters Co.)

system, with both atomizing steam water supply valves held closed.

When the pressure in the high-pressure system rises, the pressure-reducing valve will open and, at the same time, atomizing steam and desuperheating water is made available for desuperheating the steam flowing through the pressure-reducing valve.

A similar desuperheating system is installed in the turbine exhaust line. However, here the atomizing steam shut-off valve is actuated by the temperature controller. Fig. 5 shows the pressure reducing and desuperheating control panel.

Combustion Control

Fig. 8 shows the combustion-control system applied to each boiler unit. Both boilers are operated from the same pair of master control elements (upper left), with a connection being made to permit use of the master control signal at the second unit.

One master control is sensitive to pressure in the 280-psi header; the second is sensitive to pressure in the 950-psi header. A selector valve permits the operator to choose between the signals established by the two master controls, and to use either or both boilers for maintaining constant steam pressure in one of the two steam headers.

The master signal used at each boiler, regardless of the type of operation being maintained, is connected to the boiler relay station (unit 16 on Fig. 8) on the boiler control panel. This station permits either manual or automatic control of the corresponding boiler, and the output signal from the boiler relay station is connected directly to the air flow demand totalizer.

Gas Control

A blast-furnace-gas availability regulator (lower left in Fig. 8) uses gas pressure as an indication of the possibility of burning all the gas required by the boilers or being forced to accept a reduced amount because of the necessity for maintaining sufficient gas supply to other units in the steel works.

A signal from the gas availability regulator is connected to the air flow demand totalizer to establish such limits as may be necessary because of a deficiency in gas supply; the output signal from the air flow demand totalizer indicates the amount of gas to be burned by the individual boiler.

The signal from the air flow demand totalizer is connected to a steam-flow controller, and to a selector valve set in the signal system following the steam-flow controller. On automatic operation of the steam-flow controller,

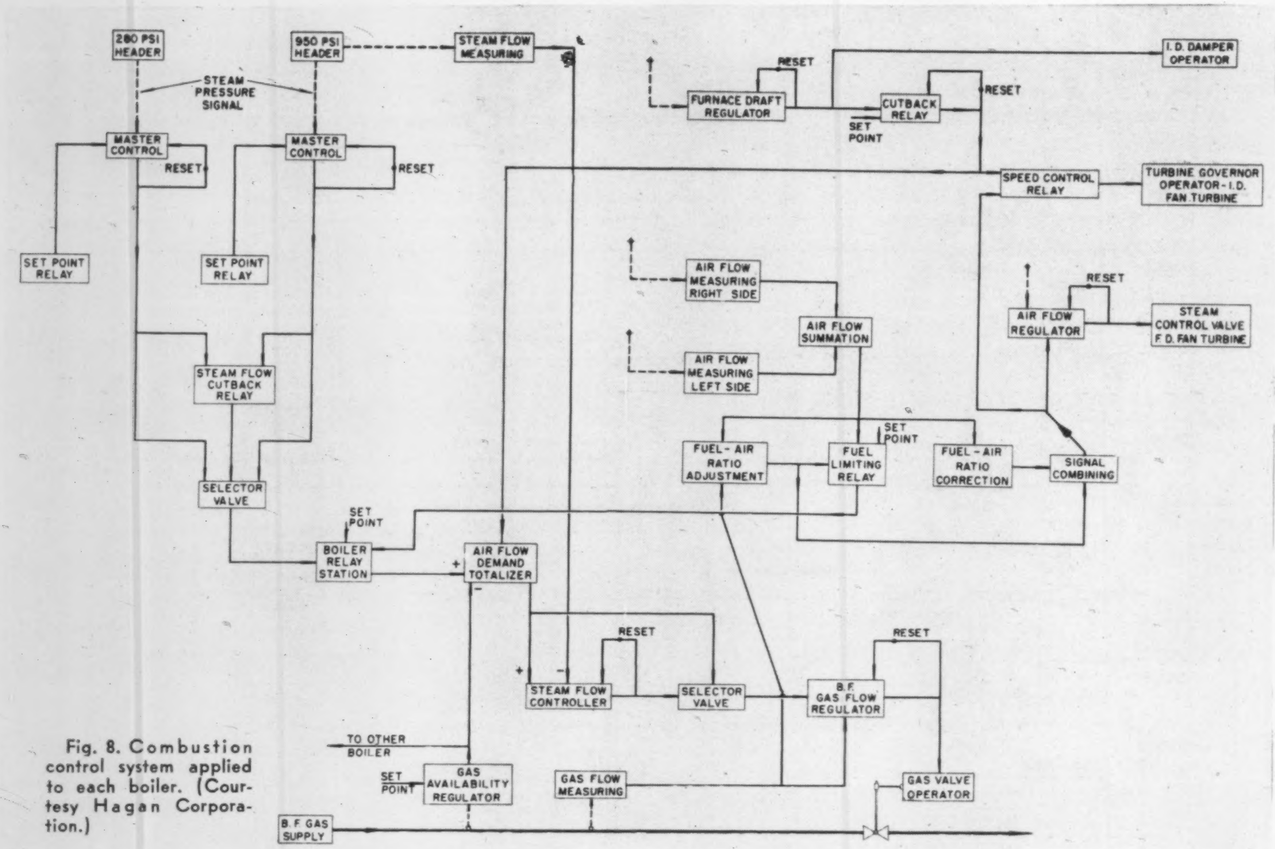

280 PSI HEADER
950 PSI HEADER
STEAM FLOW MEASURING
STEAM PRESSURE SIGNAL
MASTER CONTROL
RESET
MASTER CONTROL
RESET
SET POINT RELAY
SET POINT RELAY
STEAM FLOW CUTBACK RELAY
SELECTOR VALVE
SET POINT
BOILER RELAY STATION
AIR FLOW DEMAND TOTALIZER
FURNACE DRAFT REGULATOR
RESET
CUTBACK RELAY
RESET
SET POINT
I.D. DAMPER OPERATOR
SPEED CONTROL RELAY
TURBINE GOVERNOR OPERATOR - I.D. FAN TURBINE
AIR FLOW MEASURING RIGHT SIDE
AIR FLOW SUMMATION
AIR FLOW MEASURING LEFT SIDE
AIR FLOW REGULATOR
RESET
STEAM CONTROL VALVE F.D. FAN TURBINE
SET POINT
FUEL-AIR RATIO ADJUSTMENT
FUEL LIMITING RELAY
FUEL-AIR RATIO CORRECTION
SIGNAL COMBINING
RESET
STEAM FLOW CONTROLLER
SELECTOR VALVE
RESET
B.F. GAS FLOW REGULATOR
TO OTHER BOILER
SET POINT
GAS AVAILABILITY REGULATOR
GAS FLOW MEASURING
GAS VALVE OPERATOR
B.F. GAS SUPPLY

Fig. 8. Combustion control system applied to each boiler. (Courtesy Hagan Corporation.)

the signal representing the demand for steam is balanced by a corresponding signal from a unit measuring the rate of steam flow, and the signal leaving the steam-flow controller then is transmitted through the selector valve to the blast-furnace-gas flow regulator for maintaining operation of the main gas valve.

The demand thus established at the gas-flow regulator is balanced by a signal representing the amount of gas actually supplied, and the gas-flow regulator maintains a balance between the quantity of gas demanded and the quantity supplied.

Alternatively, the signal from the air flow demand totalizer may be taken through the selector valve (which is set manually) and this signal may be used directly at the gas-flow regulator, thus by-passing the steam-flow controller.

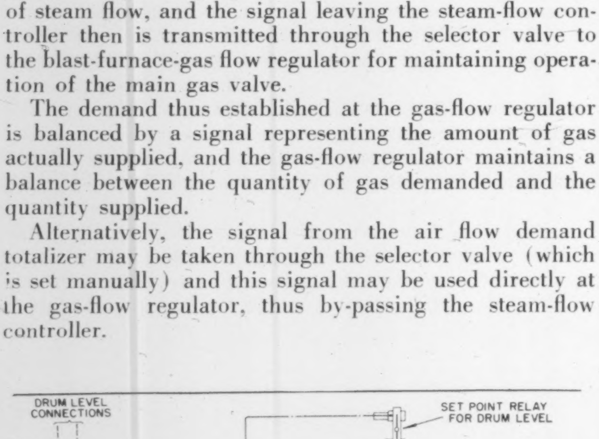

DRUM LEVEL CONNECTIONS
SET POINT RELAY FOR DRUM LEVEL
DRUM LEVEL MEASURING UNIT
STEAM FLOW CONNECTIONS
DRUM LEVEL CONTROL RELAY
MANUAL CONTROL STATION
STEAM FLOW MEASURING UNIT
FEEDWATER CONTROL VALVE
FEEDWATER FLOW CONNECTIONS
STEAM-WATER RATIO RELAY
FEEDWATER TO BOILER
FEEDWATER FLOW MEASURING UNIT

Fig. 9. Three-element (drum level, steam flow, and feedwater flow) feedwater-control system. (Courtesy Hagan Corp.)

Air Control

The measurement of blast-furnace gas supplied to the burners is transmitted as a signal to the fuel-air-ratio adjustment unit, where manual modification of the signal pressure may be made on a ratio basis. An output from this ratio adjusting unit is then connected to a signal combining relay, which serves to establish a final signal to the air-flow regulator for controlling action of the forced-draft-fan-turbine steam-control valve.

Measurements of air flow to the burners are made at both sides of the boiler, with the signals representing the two measurements being brought to the air-flow summation relay, and with the output from this relay representing total air flow. This output signal is connected to the fuel-air-ratio adjustment unit and to a fuel-air-ratio correcting unit. The former is for balancing purposes; the latter is for establishing a signal indicating any necessity for correction of the rate of combustion-air supply.

Under normal operation, the final signal transmitted to the air-flow regulator also is connected to the speed-control relay for the induced-draft-fan turbine, calling for speed changes of the I.D. fan approximately in step with changes in output of the forced-draft fan.

Furnace Draft

A constant furnace draft is maintained by means of a regulator connected into the furnace and sending a controlling signal to the induced-draft-damper operator.

Precautions Against Excess Fuel

In order to limit the input of fuel and combustion air to the capacity of the fans as operating at any time, a cutback relay receives the signal from the furnace-draft regulator, and in turn establishes a limiting signal when the furnace-draft regulator has positioned the induced-draft damper at approximately wide-open position. The output signal from this cutback relay is connected to the

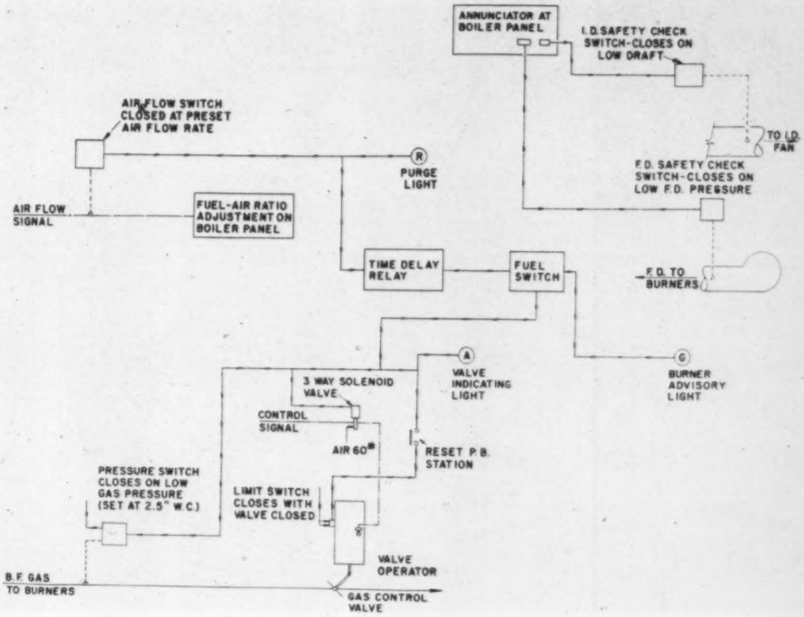

ANNUNCIATOR AT BOILER PANEL
I.D. SAFETY CHECK SWITCH-CLOSES ON LOW DRAFT
AIR FLOW SWITCH CLOSED AT PRESET AIR FLOW RATE
TO I.D. FAN
R
PURGE LIGHT
F.D. SAFETY CHECK SWITCH-CLOSES ON LOW F.D. PRESSURE
AIR FLOW SIGNAL
FUEL-AIR RATIO ADJUSTMENT ON BOILER PANEL
TIME DELAY RELAY
FUEL SWITCH
F.D. TO BURNERS
A
VALVE INDICATING LIGHT
G
BURNER ADVISORY LIGHT
3 WAY SOLENOID VALVE
CONTROL SIGNAL
AIR 60#
RESET P.B. STATION
PRESSURE SWITCH CLOSES ON LOW GAS PRESSURE (SET AT 2.5" W.C.)
LIMIT SWITCH CLOSES WITH VALVE CLOSED
VALVE OPERATOR
B.F. GAS TO BURNERS
GAS CONTROL VALVE

Fig. 10. Purge interlock system for purging boiler after shutdown. (Courtesy Hagan Corp.)

speed-control relay for the induced-draft-fan turbine to indicate the need for higher speed and greater output of the fan. At the same time, the signal from the cutback relay is connected to the air flow demand totalizer to reduce the input of blast-furnace gas to the burners.

As a further check against a possibility of introducing an excess of fuel, the signal representing total combustion-air supply is connected to a fuel-limiting relay, with the output from this unit being used as the air supply to the boiler relay station. This reduces the maximum demand for blast-furnace gas if the delivery of combustion air is reduced for any reason.

The master panel is shown in Fig. 3. The boiler panel is in Fig. 6.

Feedwater Control

The three-element feedwater-control system for each boiler is shown in Fig. 9.

Three measuring elements are used, one for steam flow leaving the boiler, one for feedwater flow to the boiler, and a third for drum level.

Primary control of the feedwater control valve is secured by measuring the difference between the rate of steam flow and feedwater flow, and substracting steam flow from feedwater flow at the steam-water ratio relay. The signal leaving this relay is connected to the drum-level control relay, which sends a pneumatic signal through a manual control station to secure approximate position of the feedwater control valve.

The signal from the drum-level measuring unit is connected to a set-point relay for the drum level, and the signal leaving this unit is indicative of any departures of drum level from standard value. This signal is connected to a separate chamber of the drum-level control relay, and indicates the need of any changes in feedwater flow to bring level back to normal value.

Purge Interlock

The interlock system for purging the boiler after shutdown (Fig. 10) prevents the possibility of introducing fuel when the fan is not delivering at the required rate. An air-flow switch closes at a pre-set air-flow rate taken from the air-flow signal going to the fuel-air ratio adjustment on the boiler panel. When this switch closes, a red purge light comes on, indicating the time-delay relay is energized. The fuel switch is then turned to "fuel on" position, and when the pre-set time has elapsed, a green burner advisory light comes on, and the three-way solenoid valve is energized. This allows the control air signal to go to the valve operator. The valve operator does not function until the limit switch is energized by the reset push-button station, which is indicated by an amber light. There is also a pressure switch which shuts off the blast-furnace gas in event of low gas-pressure.

Training Operating Personnel

A thorough knowledge of equipment is a prerequisite to successful operation. Therefore, a training program was planned and successfully administered as follows:

1. *Two-week Training Course*: All operating personnel were relieved from their former duties two weeks in advance of the expected starting date to attend the training course, eight hours a day. The first week consisted of a general description of the entire project and its operation coupled with field inspection. The second week, consisting of a more detailed study of the major pieces of equipment, was given by the various manufacturers involved.

2. *Training Manual*: All personnel attending the course were given a personal copy of all material used in the class room.

3. *Checking out and Testing Equipment*: All operators assisted the manufacturers in the checking out and testing of the new equipment before operation.

4. *Double Crews*: The operators worked twelve-hour shifts in order to double up their crews the first few weeks of operation; thus each boiler had the individual attention of a full crew,

5. *Engineering Assistance*: The Power and Fuel division had men on each turn for several weeks to offer engineering assistance and observe preliminary operations, thus helping to solve the many minor operating "bugs" that occur when starting a new boiler house.

As there have been no mishaps in the operation of this new boiler house and associated equipment, the cost of training the men seems to have been fully justified.

Problems of a new Soaking-Pit Installation

This résumé of the design factors, instrumentation, light-off, and operation of a new soaking-pit installation emphasizes the importance of proper operator introduction to new instrumentation. Included are the control systems for temperature, air-fuel ratio, combustion-air temperature, collector-flue draft, pit pressure, recuperator temperature, and safety devices. Air supply problems are discussed.

A. F. ROBBINS and **H. MEEK**
Crucible Steel Co. of America

TO KEEP PACE with the industry and to be consistent in its expansion and modernization program the management of Crucible Steel Co. of America started discussion in 1951 on a soaking-pit expansion program for its 44-inch blooming mill at Midland, Pa. The ten existing blocks of soaking pits had four holes each, were producer-gas fired, and of the regenerative type. Each hole had a rated capacity of 2.5 product tons per hour with a fuel efficiency of 1.9 million Btu per product ton, or 3.2 charged tons per hour with a fuel efficiency of 1.5 million Btu per ton. The decision was made to replace two blocks of the existing type with two blocks of coke-oven-gas-fired modern pits.

The various bids on pit construction were almost identical in size, cover crane, refractories, burners and controls, and mechanical details; the difference was entirely in the type and location of recuperators for reclaiming heat in the waste gases, and returning this heat to the burner in the form of preheated air. The first consideration, therefore, was the economics of air preheat temperature and the determination of the amount of preheat desired.

Preheat Considerations

Two arguments advanced in favor of higher air preheat are higher production per unit of area and lower fuel consumption; production can be increased from 20 to 30 percent by an increase in air preheat from 700 to 1500 deg F when heating carbon steels. However, we could not expect this benefit for our grades of alloy steels because the increased production is obtained by much higher flame temperature during the initial stages of heating, which was not permissable with the majority of grades heated at Midland. The only guaranteed benefit we could expect would be a decrease in fuel consumption from about 1 million Btu per ton with 900-deg-F air preheat to about 0.65 million Btu per ton with 1500-deg preheat. It was decided the fuel savings to be realized from the high-preheat-air-type pits would not offset the difference in installation costs between the high- and low-preheat-air types; it was decided to install two blocks of three holes, each of the low-preheat-air type.

Description of Equipment

To better understand the problems encountered during the early months of operation, a brief physical description of the pits and controllers is in order. Each hole (Fig. 1) is one-way top-fired with 500-Btu coke-oven gas or mixed gas (coke-oven gas and natural gas and air) with one hot-air-type burner having a rated fuel release of 20,000,000 Btu per hour. The burner used is essentially a 6-in. gas pipe, supported through the center of the hot-air pipe, with a cap having evenly spaced holes. Combustion air is entrained into the gas by means of a circular vane.

The inside dimensions of the pit are 22-ft. long by 8-ft. wide by 12½-ft. high from the top of the coke breeze (which is 12-in. deep) to the top of the end walls. Each hole has two flues (with a total area of 9.54 sq. feet) carrying waste products of combustion into the collector flue,

---

Presented at Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, March 25, 1954.

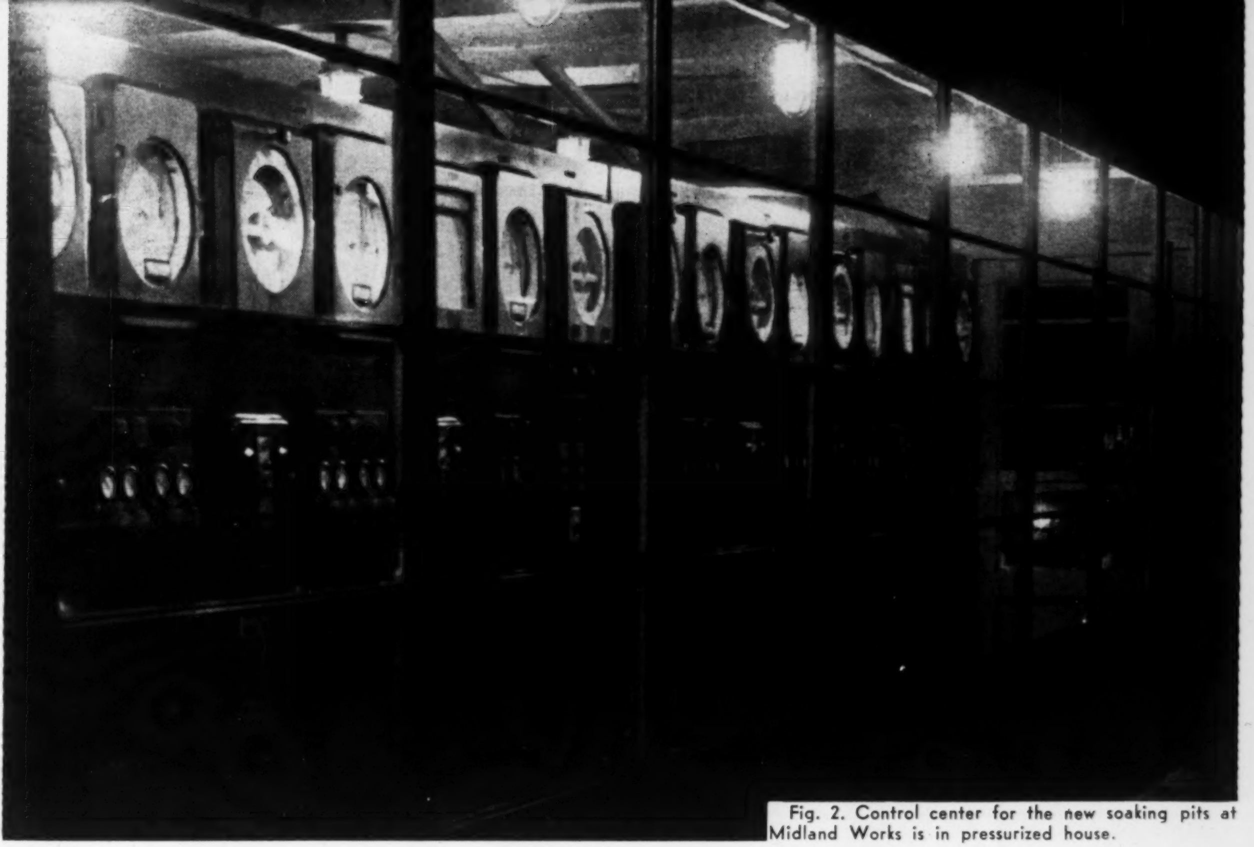


Fig. 2. Control center for the new soaking pits at Midland Works is in pressurized house.

which has an area of 32.8 sq. feet and carries the waste gases from three holes to a metallic recuperator.

Combustion air is supplied by an overhung-type blower (rated at 1750 rpm, 10,800 cfm at 12-oz pressure) to the pits through the metallic recuperator, where the air is ultimately preheated to 900 deg F. To obtain 900-degree preheated air and to safeguard the recuperator elements it is necessary to cool the waste-gas temperature to 1800 deg F. This is accomplished by drafting cold air through two openings in the waste-gas duct in the recuperator leading to the elements. Control of this will be discussed.

Each hole is equipped with electric temperature control, pneumatic air-fuel ratio control, fuel and air flowmetering (both recording and integrating), and pit-pressure recording. Each block of three holes has collector flue draft control, combustion air temperature recording with automatic temperature compensation, and a three-point recorder indicating diluted waste-gas temperature in the recuperator, waste-gas temperature leaving the recuperator, and another preheat air-temperature record. This instrument also controls the waste-gas temperature in the recuperator. Total fuel flow to the two blocks is metered, recorded, and integrated. Following is a description of the component parts of the instrumentation.

Temperature Measurement and Control

Each pit was equipped with two holes in the end opposite the burner for a hermetically sealed radiation-type "Rayotube" element sighted on a closed-end tube. One hole presently being used is 6 feet from the top of the coke breeze, the other hole is 8½ feet (for use with taller ingots). The output from the "Rayotube" is measured and recorded. An electronic valve position controller with proportional, reset, and rate action controls an electric-operated valve-drive to position a 6-in. V-port gas butterfly valve to satisfy temperature requirements. The flow of the coke gas is measured and recorded by an air-fuel recorder.

Air-Fuel Ratio Control

The air-fuel ratio regulator is of the double-diaphragm type; the outboard diaphragm is sensitive to variations in fuel flow, and the inboard diaphragm is sensitive to variations in combustion air flow. Any unbalance between the pressures acting on the diaphragm causes the pneumatic signal generated by the regulator to change and restore the balance by repositioning a 16-in. combustion-air valve, thus regulating the flow of air to the burners. A fulcrum on the ratio regulator changes the air-to-fuel ratio setting.

Combustion-Air Temperature Compensation

A chromel-alumel thermocouple in the hot-air duct (just downstream of the recuperator) is connected to an air temperature transmitter. The transmitter (which also records the temperature) generates a pneumatic signal which is ultimately impressed on a diaphragm-operated fulcrum positioner connected to the air-fuel ratio control. The ratio setting of the air-fuel ratio regulator is thus varied automatically to compensate for combustion-air temperature.

Collector-Flue Draft Control and Pit-Pressure Measurement

The flue draft controller is a cam-loaded diaphragm type generating a pneumatic signal which remains constant so long as the flue draft (measured in the collector flue approximately midway between the recuperator and the inside pit) is at control point and a 0-psi signal is imposed on the cam-loaded head. Any change in the flue draft away from control point causes the pneumatic output of the regulator to change, thus repositioning the stack damper by means of an air-operated cylinder to return the draft to control point. Originally, when the pit cover was to be lifted a solenoid valve (operated by the cover limit switch) was to change the air loading on the cam-

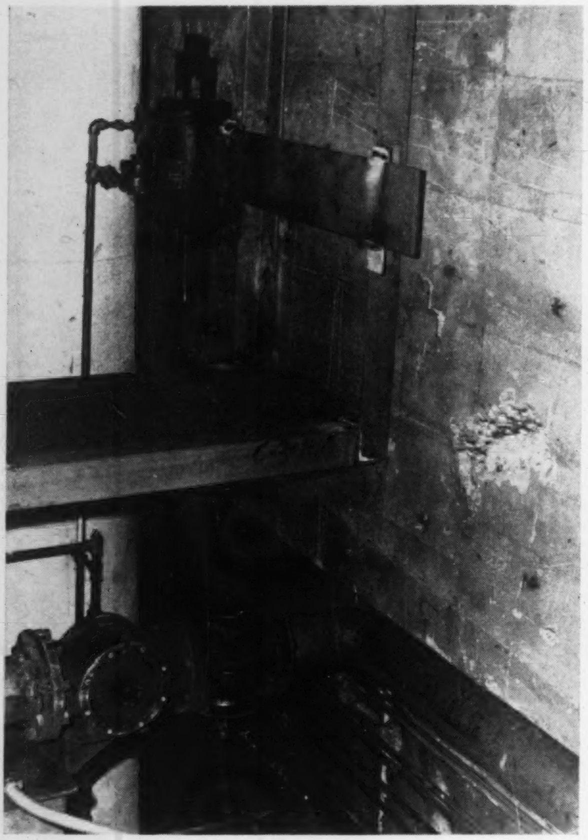


Fig. 3. Combustion-air control valve and cylinder operator.

loaded head to any predetermined value to position the damper permanently while tne cover was open. This last part of the damper control was one of our chief concerns and seems to be a problem inherent to central damper control. Fortunately it has never been necessary to use this feature, probably for two reasons: (1) the flue draft is barely on the negative side, about –0.005 to 0.01 w.c., and (2) because of the tight seal around our cover.

Each pit is equipped with a pressure tap located opposite the burner and flue side, 3 feet from the top of the coke breeze. These pressures are recorded on a 3-pen recorder for each block. Our pit pressures vary from +0.005 during soaking period to in excess of +0.15 during firing periods. We believe the ability to maintain a pressure at all times in these pits is responsible for a large part of their success.

Recuperator Temperature Control

As mentioned, the maximum gas temperature to which the recuperator elements should be exposed is 1900 F. To assure that this would never be exceeded a two-fold control was installed. The amount of cold air being drawn into the waste-gas stream is determined by two valves on two openings. One valve is positioned by a throttling control to maintain a control setting of 1800 F. Should the temperature of the waste gases reach 1900 F a switch is thrown, opening the second solenoid-operated valve. This system is wanting under certain conditions; if the stack damper control should fail and the damper assume a position to create too high a waste-gas velocity because of the resultant increase in waste gases, it is at times impossible to draw in enough air to lower the waste gas to the desired temperature. We are now experimenting with a forced-air system. Fortunately, whenever a condition has occurred to create too high a recuperator temperature it has been caught before any damage could be done to the recuperator elements.

Automatic Fuel Shut-Off and Damper Positioning

Originally, the controls were designed to incorporate limit switches on the covers to automatically shut off the fuel to each pit and to position the damper when the cover was lifted. The reason for not positioning the damper has been discussed.

As the cover crane was operated from the heater platform, it was decided that it would eliminate precariously positioned switches to have a manual switch on the cover-lift panelboard for the operator to control the fuel to each pit. Using a 60-sec. electric valve drive on the gas valve, it was found advantageous to start the fuel before the cover was over the pit. This system also permits the heater to take fuel off any one pit without entering the control house.

Air-Fuel Fail-Safety Device

Two pressure-operated switches in series (one on the outlet of the combustion-air blower, and the other on the fuel-gas manifold to each block) operate a solenoid which controls the air pressure to an air-motor-operated valve in the main gas line. Should the blower fail or the gas pressure drop below a preset point, the solenoid is operated, changing the air pressure to the safety valve and shutting off the flow of gas to the three holes.

Operational Problems

As is usual with any new installation there were certain problems to be met before and after light-off. One of those foremost in the minds of everyone concerned was the attitude of the heaters toward the new fuel and controls. Heretofore, the heaters had been accustomed to producer-gas-fired pits and simple on-and-off temperature control. Before the installation was complete, all of the heaters involved were taken to Wheeling Steel in Steubenville where they were free to discuss with heaters and foreman an installation similar to ours. We were grateful for this opportunity because confidence in automatic temperature and fuel-air-ratio control was instilled in the heaters before it became necessary to face our own installation. We also made it clear that the controllers were in no way "heater" controls; they were merely aids at their disposal. This attitude still exists; as a result we have received the fullest cooperation from the operators.

In December, 1952, with construction almost finished, the pits were lighted off. Typical of any steel-mill-furnace light off, a comedy could be written, but despite blown fuses, frustrating hours of work on the automatic cover crane, control-air and impulse-line leaks, and the usual problems that beset a light off, we charged our first steel and got it out in beautiful condition on schedule.

In the first week of operation the confidence of the operators was almost destroyed. Our temperature-measuring elements began to read low by 100 and 200 degrees F. This was diconcerting, particularly when optical checks substantiated the operators' claims. It was found that the lens of the "Rayotube" exposed to the atmosphere had collected a coat of oil film and coke dust. Using air to keep them clean was out of the question; using "typical" plant air probably would have aggravated the situation. Rushing to the nearest "5 and 10" we purchased some cheesecloth to make filters, which proved to be successful. We have refined this filter somewhat, now finding a new use for orthopedic socks. The "Rayotube" now requires cleaning about once a month instead of once a turn, and confidence was immediately restored in the temperature-measuring device.

Meticulous effort was put forth to set up the air-fuel ratio control to establish just the proper atmosphere in each pit. This was established at about 106 percent theoretical air, which held up well throughout the complete turn down of the heating cycle. After a short time it became apparent that the steel was not being heated properly. The tops of ingots furthest from the burner were being washed and the butts were cold. Trying to get the butts hot increased heating time and aggravated the washing. Waste-gas analysis checks were made over and over again, only to find our air-fuel ratio holding steady and giving us about 106 percent theoretical air during this critical soaking period. It was finally decided that we had the wrong flame characteristic during soaking—and there was no easy way to change the burner mixture. The air-fuel control was biased to give us more and more air at low flow conditions, until at present we go from 106 percent theoretical air at high flow to 215 percent theoretical air at soaking. We were fortunate in having a control flexible enough to do this. What we are doing, in effect, is using low calorific heating with a greater mass in the soaking period. This has the advantage of more-even heat distribution, and the fluid mass aids us in maintaining a positive pressure in the pit during the soaking period. The results of this change were astounding—we have more-evenly-heated ingots, the washing and cold butts disappeared, our tons per hour increased, and because of this our Btu per ton actually decreased despite the obvious need for higher average Btu input per charge heated. Although the scale increased in thickness, it was lighter and loose, a condition much to the liking of the operators.

The control installation was purchased without any means of program control—that is, no method for setting the time required to approach control point. As fuel led air, as soon as the pit was charged, maximum fuel would come on and control point would be reached quickly. The operators and metallurgists cringed at every temperature chart and steadfastly maintained that something had to be done. In order to get a satisfactory heating curve the temperature control had to be put on manual until control point was reached. This method of operation had its obvious drawbacks, so it was decided to limit the fuel input by installing a regulator in the main gas line to both blocks. Although this has restricted our charging to the point where our tons-per-hour drop when over 33 percent of our bottom area is covered, it has satisfied the operators and metallurgists. By keeping the pits charged as close to the 33 percent area as possible, we feel we are losing little production.

Air Supply Considerations

When pneumatic control is used, a steady, clean supply of compressed air is necessary. Our plant air supply was immediately discarded as a source, and three small compressors were purchased to supply air not only to the new pit installation, but to the on-off controls on the old blocks, which are air operated. As a safeguard against power failure the plant air supply was tied into the air header as a secondary source. This combination was too much. Oil leakage by the compressor piston rings put oil into the control air system, and intermittent opening of the plant air supply into the control air put water into the system. You are probably familiar with the results. We are not satisfied with the air supply system, and at present are surveying the possibilities of filtering the entire plant air supply to the blooming mill. Preventive maintenance by periodic cleaning of the parts affected by the poor air supply is now practiced.

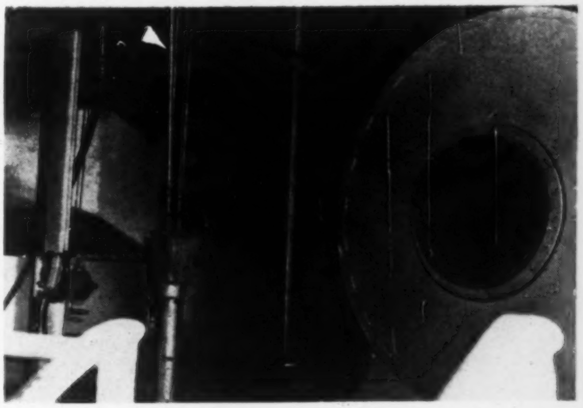


Fig. 4. View of metallic recuperator.

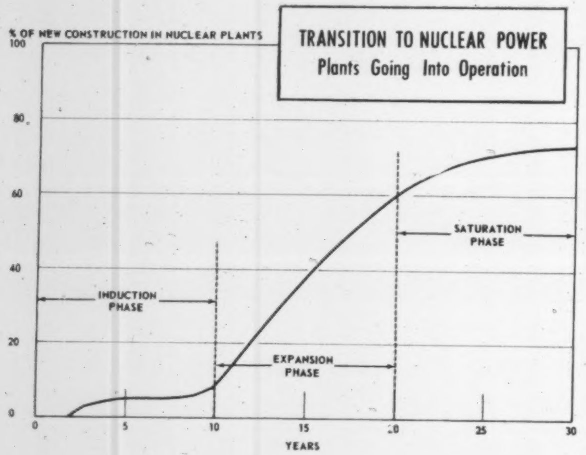
Maintenance and Location

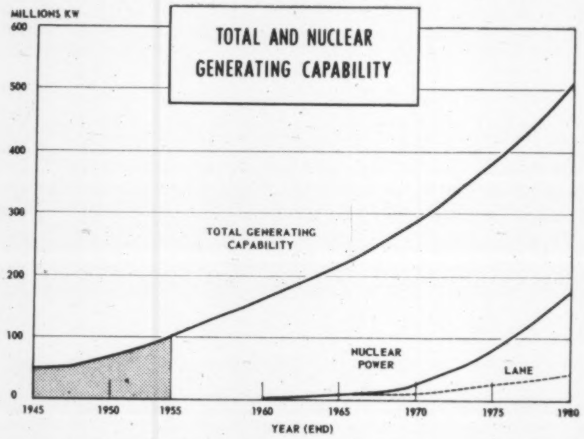
Preliminary discussions on control locations found everyone agreeing that the control cylinders on combustion-air and fuel valve-drive motors should be located as near to the burner as possible. This located the equipment just above the outlet flues, which formed a convenient working platform when covered with grating, and a solid flooring overhead between the two blocks. The first warm weather proved this location to be a mistake. The ambient temperature got well above 200 deg F, making it impossible to service the equipment. Attempts to cool the area with fans and blowers proved unsuccessful, so it was decided to move fuel valves, valve drives, and air cylinders to a cooler spot. Good planning and a convenient down period allowed this to be done with no lost heating time.

The type of air-fuel-ratio and damper control was new to our plant. Our instrument department had no one with experience on this type of equipment. Two men were sent to the school conducted by the company furnishing the controllers. This formal schooling, plus the experience of working with service men during initial installations, gave our people sufficient background to eliminate the need for outside help. With our expansion program bringing many new and different types of controllers into our plant, it is a tribute to our instrument department that they have acclimated themselves to all types and have done an excellent job of maintenance.

Results

Despite the problems encountered, everyone is satisfied with the performance of the new pits. The steel furnished the bloomer consists of every imaginable grade—28-percent carbon steel, 69-percent alloy steel, and 3-percent stainless. Our 5 electric furnaces and 10 open hearths melt the steel and teem it into 24 x 24, 26 x 26, and 27 x 27 B. E. U. moulds with hot tops. Much of it is held 1½ to 3½ hours in the moulds before stripping, causing track time of 3½ to 5 hours. An ideal charge in the new pits is fourteen 24 x 24's, twelve 26 x 26's, or eleven 27 x 27's. This seems to be the point of diminishing returns as one more ingot charged lowers the tons per hr. drastically. With the above charges the average pit heating rate from charge to draw is 9.5 tons per hour, with a net heating rate of 0.47 million Btu per ton. An average month's performance would be 7.0 charged tons per hour with a fuel economy of 0.65 million Btu per ton. Considering the types of steel being heated, controlled heating cycles required, and track times, we believe the pits are doing an excellent job.





Nuclear Power Developments

W. KENNETH DAVIS
U. S. Atomic Energy Commission

FROM the AEC point of view, the first goal is to develop at least one type of reactor to be economically competitive with conventional power plants, at least in some areas of the United States.

There have been encouraging signs during the past few months that industrial groups taking a realistic look at the cost of construction of "nuclear boilers" can now foresee much lower costs than previously. Costs as low as $80 to $100 per kilowatt of capability for the nuclear boiler, that is, reactor, including the first core, have been estimated for nuclear power plants of 75,000 to 150,000 kilowatts of electrical capability. While this is still substantially more than the $40 to $70 per kilowatt for conventional boilers of the same size, it is encouraging. Our very first full-scale nuclear power plant—The Pressurized Water Reactor now under construction at Shippingport, Pennsylvania—is expected to have a "reactor boiler" cost of $37,500,000 for 60,000 kilowatts of electrical capability —over $600 per kilowatt.

Expansion Rate

There has been a good deal of speculation as to the rate of expansion of the nuclear power industry. In my view, we can look forward to three phases in the transition to nuclear power plants. During the first or "induction phase," it is anticipated that some fairly large nuclear plants will be built, largely with private funds (Fig. 1).

At some point in time the degree of confidence in the eventual economic advantages of nuclear power will become so strong that a relatively large proportion of new power plants will be nuclear. This will be largely a psychological point. However, when it is reached, it is not difficult to foresee the proportion of nuclear power plants to the total number being built increasing from perhaps 5 percent to 60 percent in 10 years or less.

This point will undoubtedly be reached long before anyone can seriously claim to have generated economic nuclear power and will be largely psychological in nature.

Size of Nuclear Power Industry

After considering various estimates, including those made recently by industry, it seems to me that the generating capability of the nation should increase from the current level of approximately 100 million kilowatts to more than 200 million by 1965 and to nearly 400 million by 1975 (Fig. 2). I think that the corresponding power generated might go from the current level of nearly 500 billion kilowatt-hours to more than 1000 billion in 1965 and to nearly 2000 billion in 1975. Of course, a great deal can happen to alter these estimates.

If these "fine" predictions come to pass, the United States by 1977 will have something like 100,000,000 kilowatts of electrical generating capability in nuclear power plants—about as much capability as the nation has now in conventional plants. These nuclear plants would probably represent an investment of nearly $20 billion. When one thinks of the various new facilities and plants necessary to supplement and service such a large nuclear power capacity, it is obvious that there will be many opportunities for large and small industries to make a place for themselves in this business during the next 20 years.

The United Kingdom has announced a tentative program for the development and construction of nuclear power plants over the next decade. The British hope to have 1,500,000 to 2,000,000 kilowatts of nuclear power generating capacity in use by 1965. If developments in this country go as I have estimated, the United States will have 2½ to 3 times as much capacity in operation by 1965. Proportionately, this will not be doing as well as the British who today have only one fifth as much installed capacity as we have.

Abstracts from a talk delivered at the 17th Annual Meeting of the American Power Conference, Chicago, Ill., April 1, 1955.

Enroll now . . .

for COMPUTER CLINIC
CONVEYOR CLINIC
LABORATORY AUTOMATION CLINIC

features of the

SECOND INTERNATIONAL AUTOMATION EXPOSITION

Chicago Navy Pier, Nov. 14-17

COMPUTER CLINIC

The Second Annual Computer Clinic offers each registrant a choice of six 2-hr. lecture and demonstration classes on analog computers, digital differential analyzers, data processors and special-purpose computers. A handbook, containing all the presentations of the 12 computer principals will be given each registrant. Advance registration is offered. Registration will be terminated when class facilities are filled. No registrations from employees of computer manufacturers will be accepted.

CONVEYOR CLINIC

A clinic also is being arranged on conveyors. Each session of this clinic will be focused on a different, significant, functional phase of the application of conveyors in supplying the prime mechanism to automation. Tentative reservations are being accepted.

LABORATORY AUTOMATION CLINIC

A shortage of research engineers and laboratory technicians has been recognized for some time. To help overcome this shortage is the purpose of the Laboratory Automation Clinic. The sessions in this clinic are designed to provide information on some of the automatic laboratory devices recently developed. Tentative reservations are being accepted.

Registration fee is $5.00

Second International Automation Exposition
845 Ridge Ave., Pittsburgh 12, Pa.

I am interested in attending (check only one):

☐ COMPUTER CLINIC
☐ CONVEYOR CLINIC
☐ LABORATORY AUTOMATION CLINIC

Name ....

Title ....

Company ....

Address ....

SHADOGRAPH

Weight Indication by a Beam of Light Assures Fast, More Accurate Readings

SHADOGRAPH Scales are precision weighing instruments designed to meet the requirements of modern industry for accurate weight control. Shado-edge indication, projected by a beam of light, eliminates all friction of indicating mechanism. Parralax readings are impossible. Special hydraulic damping mechanism, plus short lever fall, brings indicator to rest quickly.

Models are available in sizes and capacities for every precision weighing job. They are widely used by industry for compounding formulas, batching, many laboratory uses. Also for weigh-counting and inventory of small parts; for checkweighing castings, balancing and weight control of machined products.

SHADOGRAPH scales are available in capacities from 50 grams up to 75 lbs, with sensitivities to meet most any weighing requirement. Write for complete details.

Sales and Service from Coast to Coast

Exact Weight Scales

Better quality control
Better cost control

THE EXACT WEIGHT SCALE COMPANY

951 W. Fifth Avenue, Columbus 8, Ohio
In Canada: P.O. Box 179, Station S, Toronto 18, Ont.

Please send full information on Shadograph Scales

Name ....

Address ....

City ....Zone ....State ....

For more information circle 17 on inquiry card.

Journal of the SCMA . . .

SOUTHERN CALIFORNIA METER ASSOCIATION

President: *Glen C. Wilson*
Vice-President: *Glen G. Gallagher*
Auditor: *Norman Jaffe*
Past Pres.: *James A. Serey, Jr.*
Secretary-Treasurer: *Geo. H. Forster, Jr.*, 640 Fillmore St., Fillmore, Calif.

Why A Relief Valve?

Safety engineering requires proper use of relief valves, and proper use demands the foreseeing and diagnosing of any combination of equipment or human-element malfunctions. Examples are given where relief valves are necessitated by possibility of fire, blocked inlets or outlets, instrument or equipment failure, water hammer, and underpressurizing.

JOSEPH CONISON
The Fluor Corporation, Ltd.

A "MUST" in all chemical processing and power plants is the proper use and selection of relief valves, as well as the complete coverage of hazardous conditions involving the use of relief valves. Relief valves protect equipment from rupture, reduce fire hazards, increase safety to personnel, and assure continuous plant operation.

The importance of relief valves to the public welfare has grown to such an extent that all cities, counties and states, as well as the federal government, have specific relief valve codes that are strenuously enforced. Plants often are forbidden to start up because of not adhering satisfactorily to a relief-valve code governing that particular locality.

Relief valves in general are discussed in the 1951 API-ASME[1] and the 1952 ASME "Unfired Pressure Vessel Codes." Mentioned as causes for over-pressure are fires or other unexpected sources of heat. However, to diagnose properly a need for a relief valve, safety engineers should consider over-pressure due not only to heat but

---

[1] American Petroleum Institute—American Society of Mechanical Engineers

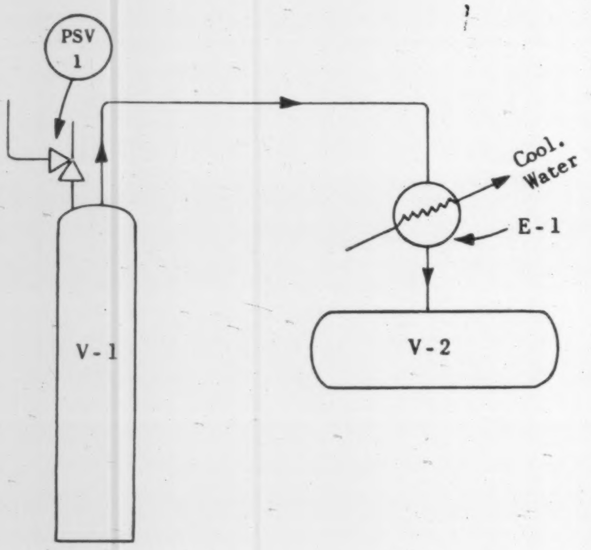


Fig. 1. Interconnected equipment units which cannot be isolated from each other are treated as one unit and protected by one relief valve. In this application, units V-1, E-1 and V-2 are protected by PSV-1.

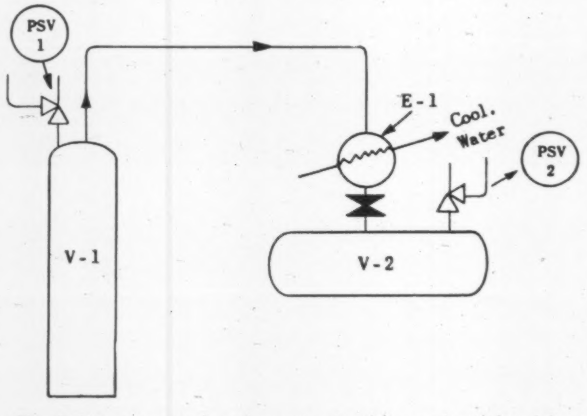


Fig. 2. Interconnected equipment units that can be isolated by a block valve are treated as separate units, and each unit must be protected by a relief valve. PSV-1 protects interconnected units V-1 and E-1, but block valve between E-1 and V-2 necessitates relief valve PSV-2 for V-2.

also to (a) process variations, (b) abnormal process operation, and (c) equipment failure.

Fire

Fire is listed first and is number one in the minds of safety engineers in petroleum refineries and chemical plants because it is a prevalent and devastating hazard.

If equipment containing liquid is exposed to fire, it is possible for the heat from the fire to vaporize the liquid. The pressure developed in the vessel will be a function of the temperature and composition of the liquid-vapor state. One way to keep the pressure down is to provide an escape for the vapors generated. If this is not done, it is possible to develop excessive pressure beyond the rupture point of the equipment. The types of equipment that can be exposed to fire are heat exchangers, fractionating columns, storage vessels, and operating vessels.

In general, when applying relief valves, equipment that may be connected together by piping that does not contain valves which can isolate any item may be considered as one unit requiring a relief valve or valves. If the items can be separated from one another by valves in the connecting piping, then each item shall be considered as a unit with its own individual relief valve or valves. For example, in Fig. 1 the items are not separated by valves; therefore, PSV-1 can be used to protect V-1, V-2, and E-1. In Fig. 2, V-1 and E-1 are separated from V-2 by a valve; therefore, PSV-1 can be sized to relieve V-1 and E-1, and PSV-2 sized to relieve V-2.

Blocked Outlets and Inlets

Liquid-filled lines that can be blocked in and also exposed to the sun should be protected by relief valves. The sun beating down on bare pipe can heat the entrapped liquid, cause expansion of the liquid, and create enough pressure to rupture the piping.

If the cold side of a heat exchanger is liquid filled and can be blocked, then the cold side requires a relief valve. Referring to Fig. 3, A, it is possible to close the block valves on the cold side of the heat exchanger and at the same time have hot liquid go through on the "hot" side. Thus the "hot" side can transmit heat to the "cold" side, expand the blocked-in liquid, and rupture the shell.

A fired-tube heater with liquid oil in the coils requires relief protection when the coils can be blocked in. In Fig. 3, B, the heater can have the coils blocked in and heat applied at the same time. The coils can be blocked in by closing the two block valves "a" and "b," or by closing the outlet block valve and the check-valve preventing any reverse flow, or by having the outlet block valve closed and the pump pumping liquid through the relief valve. Owing to the possibility of the latter conditions, it is preferred that the relief valve be placed on the coil outlet side to permit flow through the coils and thus prevent coking.

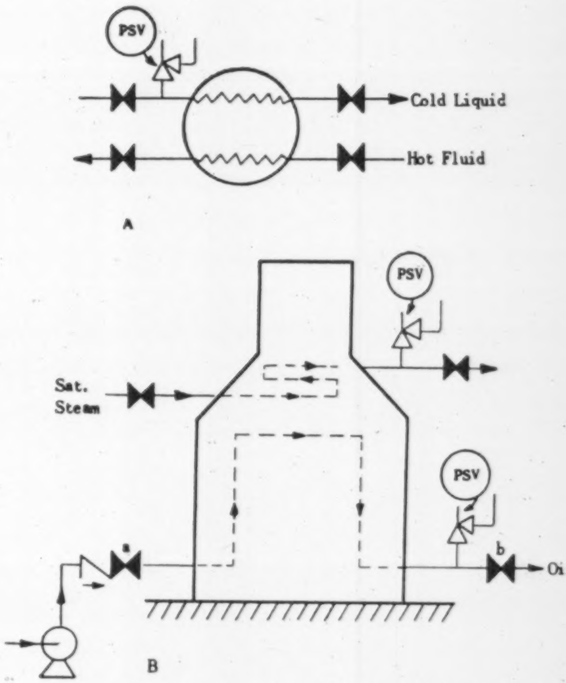


Fig. 3. Examples of relief protection for liquid-filled lines which can be blocked off. In A, the heat exchanger requires relief protection on the cold side because the cold-side lines could possibly be blocked and heat applied to the cold lines from the hot lines. In B, relief valve on fired-tube heater is placed on the coil outlet to permit flow through the coils and thus prevent coking; relief valve on super-heater steam coil is required because of possibility of starting up heater with steam lines blocked and condensed liquid in the steam coils.

In Fig. 3, B, it is possible to start up the heater with the valves on the steam coils closed and liquid condensed in the coils. In view of this possibility, it is necessary to insert a relief valve on the super-heater steam coil. A city inspector in a large city once refused to permit a plant from starting up until a relief valve was inserted for just such an application. This incident proves the importance of, let us say, the lack of relief valves.

Blocked Outlets

Blocked outlets can apply to (1) reciprocating compressors, (2) reciprocating pumps, (3) gear pumps, (4)

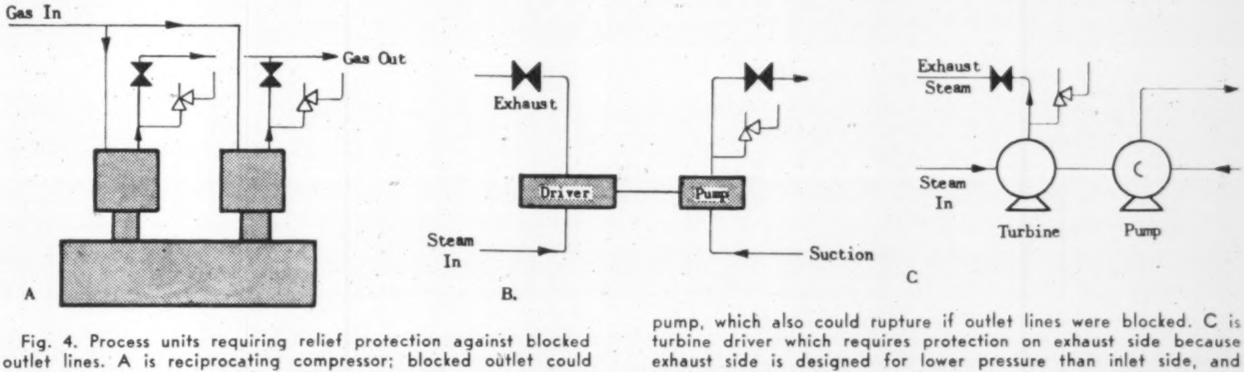


Fig. 4. Process units requiring relief protection against blocked outlet lines. A is reciprocating compressor; blocked outlet could rupture compressor case or lines. B is reciprocating pump or gear pump, which also could rupture if outlet lines were blocked. C is turbine driver which requires protection on exhaust side because exhaust side is designed for lower pressure than inlet side, and blocked outlet would cause outlet pressure to raise to inlet pressure.

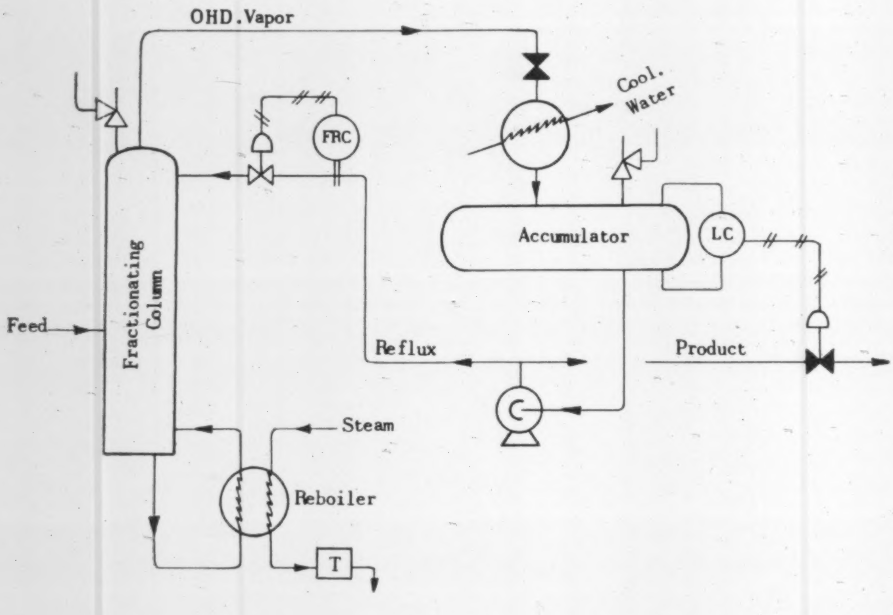


Fig. 5. Fractionating column requires relief protection because overpressure can result from blocking of overhead vapor line while heat continues, or from loss of reflux (which acts as coolant).

steam exhaust side of turbines, and (5) fractionating columns.

In the first three of these items, we have positive displacement equipment; the units are discharging constant volumes of liquid, gas or vapor. If the discharge is blocked, the units are so designed that the fluid cannot reverse itself but must go forward with the motion of the piston or gear. If it cannot go forward, then the unit will either stall or rupture the pump or associated piping. Therefore, to protect the equipment, relief valves are installed as in Fig. 4. In A and B, the relief valves may discharge to the suction side of the units.

Fig. 4, C shows a turbine-driven pump with a relief valve on the steam exhaust side of the turbine. The reason for this is that the exhaust side of a turbine is invariably designed for a much lower pressure than the inlet side. If the inlet side of the turbine were to be open and the outlet side blocked, the exhaust pressure would be the same as the inlet. It is for this emergency that relief valves are installed.

Overpressure also can be developed in fractionating columns when the overhead vapors are blocked and the source of heat to the column continues. In Fig. 5, if the block valve in the overhead vapor line is accidentally closed and heat continues to the column, overpressure can result. This necessitates use of a relief valve on the column.

Reflux Failure

In Fig. 5, the loss of reflux also can cause overpressure to the column because reflux acts as a coolant to the column. Reflux failure may be due to pump failure, instrument failure, or loss of cooling water.

Instrument Failure

Another important feature to guard against is instrument failure, including possibility of the instrument itself failing or loss of instrument air to the instruments.

One commonly considered instrument-failure possibility is a control valve "freezing" in an open or closed position. Suppose in Fig. 6, that the stripping steam to the column is at 135 psig, the maximum design of the column is 50 psig, and the control valve, FRCV, freezes in an open position. If the overhead condenser is not designed to condense the full capacity of the steam through the control valve, or if the block valve between the condenser and the accumulator is closed, then it is possible to overpressure the column with 135-psig steam.

Entrance of a fluid or vapor from a high-pressure system to a low-pressure system may sometimes be a source of equipment overpressure. In Fig. 7, the absorption of the wet gas with lean oil takes place at 450 psig. The rich oil leaves the Absorber through a level-control valve to the Deethanizing Column, which operates at 200 psig and has a maximum design pressure of 250 psig. The only thing that separates the Absorber from the Deethanizer is the control valve which reduces the pressure (as well as controls the level) down to the operating pressure in the Deethanizer. If the control valve were to freeze in an open position, then it is possible to feed an excess of high-pressure liquid and gas to the Deethanizer. If the Deethanizer is not designed to handle this high rate, relief protection must be provided.

Other possibilities to consider as the basis of instrument failure are (1) steam or hot oil control to a reboiler, (2) cooling-water control on a condenser or cooler, (3) steam control to a turbine, (4) pressure control on a fractionating column, (5) steam boiler controls.

Abnormal Process Operation

Abnormal process operation also must be considered in the application of relief valves. The human element is as much a factor as equipment elements—examples: manually shutting off the block valves on the cold side of the exchanger and opening the block valves on the hot side in Fig. 3, A; manually shutting off the block valves on the steam coil containing water (in Fig. 3,B) and keeping the heater fired up; manually shutting off discharge valves on the compressor and pumps in Figs. 4, A, and 5. These examples are just a few in which manual operation can cause overpressure of equipment, and all possibilities must be considered for sizing relief valves.

Equipment Failure

Plant cooling-water pump failure, fractionating-column reflux pump failure, and tube rupture of heat exchangers

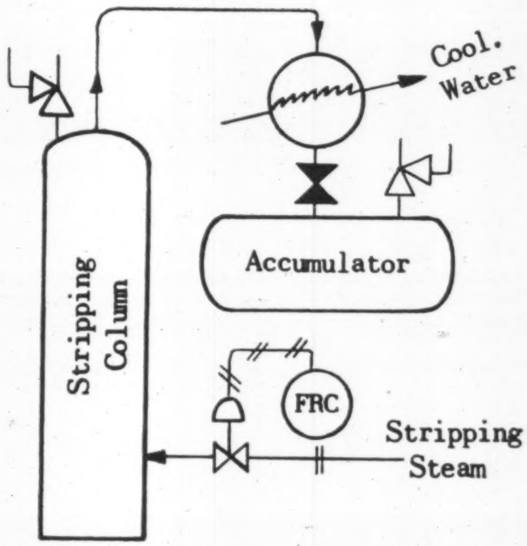


Fig. 6. Example of protection required against instrument failure. If valve controlling 135-psig stripping steam to stripping column should freeze open, the column (designed for 50 psig maximum) might be subjected to 135-psig steam pressure if overhead condenser is not designed to condense full steam capacity—or if the block valve between the condenser and accumulator is closed.

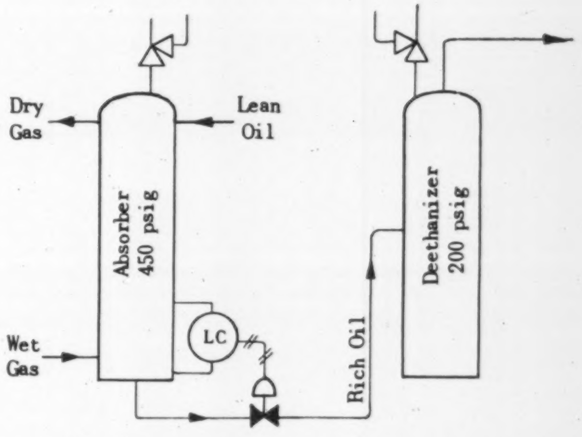


Fig. 7. Another example of protection required against instrument failure. If control valve between 450-psig Absorber abd 200-psig Deethanizer of this absorption unit were to freeze open, pressure in Deethanizer could exceed its design rating.

are the most important of process-equipment failures inducing overpressure of allied units.

Pumps may fail because of mechanical breakdowns or loss of power. In either event it is a possibility and a likely occurrence.

Exchanger tubes are subject to splitting, and consideration should be given to the source of high pressure and its effect on the low-pressure side. If, for example, a tube splits and the high pressure is on the tube side, then it is possible to overpressure the shell side, the shell piping, or the associated equipment. The same consideration should be given if the high pressure were on the shell side.

Water Hammer

The rapid shut-off of a valve in a liquid line or the shut-off of a pump may induce water hammer in piping. Water hammer fundamentally is pressure waves transmitting back and forth in a liquid-filled pipe. This pressure may reach the point whereby it can rupture piping or equipment. To protect piping and equipment from water hammer, the solution is use of a relief valve.

Vacuum Relief

Equipment not designed for vacuum service must be protected against underpressurizing as well as overpressurizing. If the atmospheric pressure on the outside of the vessel is greater than the pressure on the inside, it is possible to collapse the walls. It has been done time and again.

Full or partial vacuum in equipment may be caused by any of the following events: (1) Pumping more liquid out of a vessel than is entering. (2) Draining liquid from a vessel (such as water after a hydrostatic test) without venting. (3) Injecting cold liquid into a vessel after steaming it out.

The first two cases are obvious; withdrawing liquid without replacing the displaced volume produces a vacuum. In the third, if the vessel is full of steam and cold liquid is injected into the unit, then the cold liquid will condense the steam, reducing the volume occupied by the steam, and thus producing a vacuum.

Conclusion

If one can efficiently diagnose, then the prognosts is easy and the cure practically guaranteed. With safety engineering, such is the procedure—namely, diagnosing instances in which equipment may be subjected to overpressurizing or underpressurizing, applying the proper relief or vacuum valves, and thereby ensuring safe operation and protection of equipment. The typical applications cited will take care of approximately 95 percent of all problems in refineries, chemical plants, and power plants.

In the practice of safety engineering, the engineer would do well to consider all possible effects of the following:

1. Fire.
2. Blocked inlets and outlets, or blocked outlets.
3. Instrument or equipment failure.
4. Water hammer.
5. Vacuum, with respect to operating equipment.

One final thought. The safety features discussed are not mandatory by law in all cases. However, it is insurance for continuous plant operation, and protection for personnel and equipment. In all probability the safety equipment may never be used—which is good; but, should it be used only once, then it more than pays for itself in return on the investment.

In conclusion, the actual cost of safety equipment is low in comparison to the over-all cost of plants in operation today; cutting corners on safety equipment is penny-wise and dollar foolish.

Acknowledgment

The writer thanks the management of The Fluor Corporation, Ltd., for the opportunity granted to publish this paper, and also Mr. William H. Williams for constructive comments and suggestion of title.

July Meeting: *Thursday, the 21st, Rio Hondo Country Club, Downey, Calif.*

Feature: *James L. Donnelly, Rockwell Mfg. Co., will present a talk on "Orifice Meter Chart Integration."*

Briefs . . .

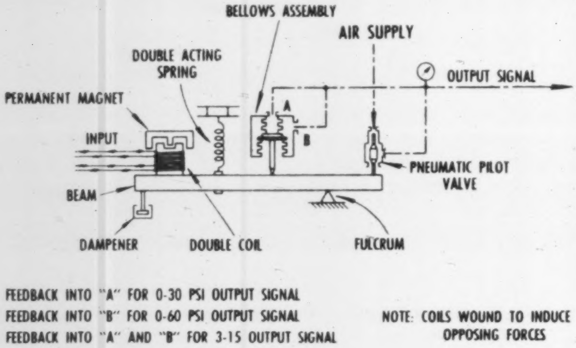
For this literature use postage-free order card on page 1017

Model "P" DC Amplifier

The Hagan PowrAmp Model "P" Direct Current Amplifier is a new, electronic, low-voltage linear amplifier designed to increase the speed and accuracy of practically all low level DC voltage measurements. It is the basic element of a completely new system for temperature measurement employing all of the standard thermocouple combinations. . . . A review of the Model "P" features reveals the wide scope of this new development (for use) with thermocouples, strain gages, resistance thermometers, radiation pyrometers, and other low-EMF-generating devices.

Speed of response is superior to present-day potentiometers . . . no slide wires or motors are used. The instrument is stable, drift-free, linear, and features range expansion or contraction about a fixed mid-scale point established by suppression.

Two electrical outputs are available—a DC voltage output and a double current output for double-coil recorders and receivers, such as the Esterline Angus and others. Current output is used also to actuate the Hagan double-coil Electro-Pneumatic Converter (Figure) to produce pneumatic outputs. Current outputs can be transmitted 7 miles.


BELLOWS ASSEMBLY
AIR SUPPLY
DOUBLE ACTING SPRING
OUTPUT SIGNAL
PERMANENT MAGNET
INPUT
A
B
PNEUMATIC PILOT VALVE
BEAM
DAMPENER
DOUBLE COIL
FULCRUM
FEEDBACK INTO "A" FOR 0-30 PSI OUTPUT SIGNAL
FEEDBACK INTO "B" FOR 0-60 PSI OUTPUT SIGNAL
FEEDBACK INTO "A" AND "B" FOR 3-15 OUTPUT SIGNAL
NOTE: COILS WOUND TO INDUCE OPPOSING FORCES

Inputs: DC—0 to 1 mv and up from grounded or ungrounded sources having source resistance of 0 to 1000 ohms. Potential must be less than 6 v . . . current drawn from the input is less than 1 microampere.

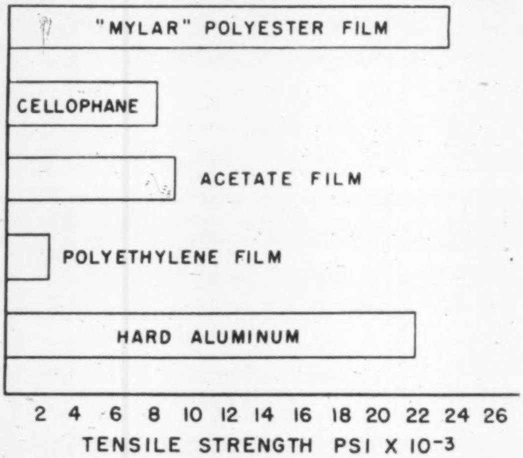
Outputs: (A) Two direct currents, 10 to 70 ma and 70 to 10 ma into 600 ohms. (B) plus or minus 3 volts—linear with input—for use on voltmeters or recorders. A minimum meter resistance of 2500 ohms per volt is recommended. (C) Conversion to 3-15, 0-30, or 0-60 psi. Model "P" 3000 and 4000 series provide outputs of plus or minus 30 volts.

Amplifier response is better than 0.1 second for full electrical output; 0.2 second for full pneumatic output. Frequency response is flat to 10 cps on electrical basis. On pneumatic basis, it varies with load; 4 cycles is representative. (*From new 12-page Bulletin MSP-111.1, Hagan Corp., Pittsburgh 30, Pa.*)

For this literature circle **401** on inquiry card.

MYLAR Polyester Film

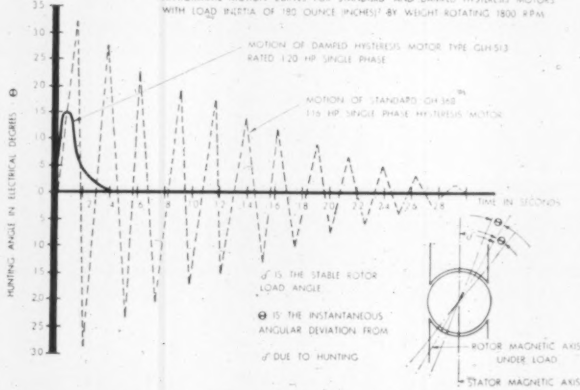
DuPont MYLAR polyester film is a film made from polyethylene terephthalate . . . is tough, durable, impermeable to a number of organic and inorganic gases. In addition, it exhibits high dielectric strength and a relatively low power factor. It remains flexible and stable from -60 to plus 150 deg. C. A typical value of dielectric constant at 25 C and 60 cycles is 3.16 . . . ideal for a variety of insulating purposes. Applications include . . . magnetic recording tapes, insulation for motor stators, fiber-drum liners, metalized laminate with aluminum, capacitor insulation, foil laminate with yarn, vapor proofing, etc. (*From new 20-page brochure TR-1, 16-page brochure TR-3, and 6-page brochure A-8447, E. I. DuPont De Nemours & Co., Inc., Film Dept., Wilmington 98, Del.*)



For this literature circle **402** on inquiry card.

Hysteresis and Salient-pole Synchronous Motors

The hysteresis synchronous motor has a rotor which is perfectly smooth and homogeneous, hence . . . there is no magnetic pulsing due to slots or pole saliency . . . is therefore much quieter and freer from vibration than other types of synchronous motors. Characteristics include: freedom from noise, vibration and hunting; constant speed; uniform starting torque; can be wound for lower speeds and greater number of poles than salient-pole-type induction motors.



The hysteresis motor, with its square speed-torque curve, might be adapted to servo work.

The salient-pole induction motor has a rotor with standard induction motor construction except that the laminations are cut out to give pole saliency . . . it starts

Introducing the NEW

PIC-600 TWINS

Increased **reliability**
and *greater* count life
in *compact* size
at *popular* prices

PIC-600
PRODUCTION INSTRUMENT COMPANY
CHICAGO
1 2 3 4 5 6
1 2 3 4 5 6
PIC-600
PRODUCTION INSTRUMENT COMPANY
CHICAGO

Born to Excel

PIC-600 Counters culminate years of research and development to provide reliability and long count-life never before approached in electric counters of their class.

They incorporate many advanced and improved design features rarely found even in larger and more costly counters.

On life test at 1000 cpm, PIC-600's have passed the 100 million mark and are still going strong, with no breakdowns and little perceptible wear.

Quiet operation; protection against dust and tampering; ease and convenience of application are a few of many features well worth knowing about.

Ask your PIC Representative or write

A few of many PIC-600 Features

- 50 Million Count-life
- 1000 counts per minute rating
- 7 watts power consumption
- Balanced armature *(for accuracy on airborne equipment)*
- Quiet operation *(no AC hum when energized)*

PIC
PRODUCTION INSTRUMENT CO.
702 W. Jackson Chicago 6, Illinois

Manufacturers of • Super-Wizard and Mercury Electric Counters • Monitor Automatic Batch Counters • Silver King and Junior King Stroke and Revolution Counters • Clipper Coil-winding Counters • Actuating Switches for Electric Counters.

For more information circle **93** on inquiry card.

COMPRESSED AIR AND GAS
COME OUT OF THE LOGAN

ARIDIFIER

Scrubbed
CLEAN AND DRY

INSTALL ARIDIFIERS ON LINES SERVING

- Paint Spray Guns
- Air Tools
- Air Hoists
- Foundry Jolting Machines
- Sand Blasting Tools
- Sand Blasting Rooms
- Metal Spray Guns . . . or Wherever the line must deliver clean, dry air or gas

On any air or gas line 92% of the dirt, oil, scale and water that enter the Aridifier is trapped and removed from circulation. The Aridifier's patented centrifugal-baffle action scrubs air and gas clean and dry . . . protects equipment, prevents freezing, fouling, corrosion and caking, produces best results with spray gun and air tool operations, etc. Easy to install. Self cleaning. Maintains itself. 10 models available. Capacity 7 CFM to 17,000 CFM.

Learn HOW the Aridifier scrubs with a patented centrifugal-baffle action.

Write for This Catalog Now!

Logan ENGINEERING CO.
4921 W. Lawrence Ave , Chicago 30, Ill.

For more information circle 94 on inquiry card.

SPRAGUE ENGINEERING CORP.

bubble-tight
4-WAY SELECTOR VALVE

A two-position, 4-way valve for air or hydraulic fluids at pressures to 100 psi and vacuum to 25".

FEATURES:

Leak free operation. Low cost. Low handle torque. Low pressure drop. Easy panel mounting. Corrosion-resistant materials—bronze, aluminum. Simple maintenance—disassembly without disconnecting lines.

SPECIFICATIONS:

1. Fittings—Model S-576 for ¼" tubing port connections per AND10056. Model S-576-1 for ⅛" female pipe thread port connections.
2. Weight 6 ounces.
3. Seals—standard commercial "O" rings.
4. Finish—black anodized.
5. Size: 3¾" wide by 2⅜" deep, including handle.

For complete information, send for Bulletin 3000.

SPRAGUE *Engineering Corporation*
1144 WEST 135TH STREET, GARDENA, CALIFORNIA

For more information circle 95 on inquiry card.

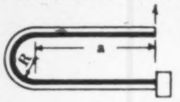
and comes up near synchronous speed as an induction motor, and runs at synchronous speed as a reluctance motor. Characteristics: Minute hunting; constant speed; wide variation in starting torque, dependent on rotor position; noisier than hysteresis type.

The curve compares a standard 1/16 hp hysteresis motor and the newer nonhunting units. (*From new 24-page Catalog el 4a, Electric Indicator Co., Inc., Springdale, Conn.*)

For this literature circle **403** on inquiry card.

Thermometals, Special Alloys

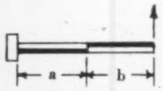
Wilco provides four groups of precision products—Group I, Thermometal (Thermostatic bimetals). Group II, Electrical contacts including silver, platinum, sintered powder contacts, collector rings. Group III, Clad and overlaid composite materials. Group IV, Special alloys, Ni-Span-C, constant-modulus alloy, high-conductivity alloy, etc. (*From new* 196-*page "Blue Book," H. A. Wilson Co., Union, N. J. Price*: $3.00)



$$\left(\frac{d}{T}\right) = \frac{2K}{t}(a^2 + \pi Ra + 2R^2)$$

$$\text{If } R = 0, \left(\frac{d}{T}\right) = \frac{2Ka^2}{t} = \frac{KL^2}{2t}$$

Reverse Welded



$$\left(\frac{d}{T}\right) = \frac{K}{t}(b^2 - 2ab - a^2)$$

$$\text{If } b = 2.4a, \left(\frac{d}{T}\right) = 0$$

For this literature circle **404** on inquiry card.

Telemetering

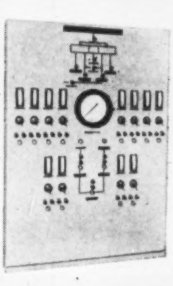
The information contained in this booklet describes Femco's electronic and relay systems for central control

Packaged Automation

complete panel units ready to operate

tailored to individual control requirements

one source single responsibility

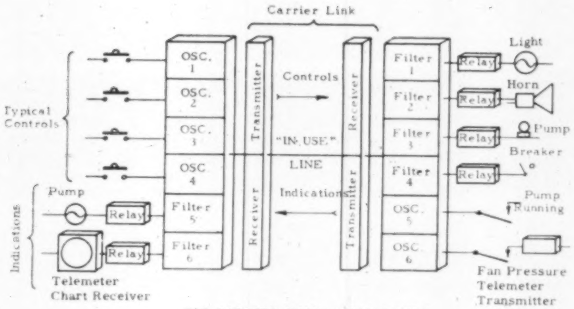


atc®

CONTROL SYSTEMS

Automatic control systems completely designed and packaged to meet your process specifications. A. T. C. or other instruments and systems mounted and wired according to each control requirement. Design backed by years of experience in all phases of electric, electronic, pneumatic, and hydraulic control of machine and process operation. Send blueprints and specifications for confidential, complete data. Automatic Temperature Control Co., Inc., 5224 Pulaski Ave., Philadelphia 44, Pa. Represented in Canada by Powerlite Devices, Ltd., Toronto, Montreal, and Vancouver.

For more information circle 96 on inquiry card.


Carrier Link
Typical Controls
OSC. 1
OSC. 2
OSC. 3
OSC 4
Filter 5
Filter 6
Transmitter
Receiver
Controls
"IN USE"
LINE
Indications
Receiver
Transmitter
Filter 1
Filter 2
Filter 3
Filter 4
OSC. 5
OSC 6
Relay
Light
Horn
Pump
Breaker
Pump Running
Fan Pressure Telemeter Transmitter
Indications
Pump
Telemeter Chart Receiver

BIT CARRIER WITH AUDIO TONES

INDEX OF SYSTEMS

TYPE SYSTEM	USE	CIRCUIT REQUIRED	TYPICAL APPLICATIONS
BIT CARRIER INDUSTRIAL SIGNAL SYSTEM	CONTROL	IN USE LINE • 1 CARRIER	COKE OVEN PUSHER TO QUENCHER, CALLING, WARNING, ALARM
BIT CARRIER SHIFT	2 CONTROLS	IN USE LINE • 1 CARRIER	VALVE CONTROL PUMP CONTROL
BIT CARRIER WITH AUDIO TONES	20 CONTROLS 20 INDICATIONS	IN USE LINE • 2 CARRIERS	SUPERVISORY CONTROL OF CIRCUIT BREAKERS IN COAL MINE
BIT STEP RELAY CONTROL AND INDICATION SYSTEM	25 CONTROLS 25 INDICATIONS	CLEAN PAIR	BLAST FURNACE SIGNAL SYSTEM, MULTIPLE CONTROL AND INDICATION BETWEEN TWO POINTS

or remote operations . . . Femco's "Bit" system uses modern information theory. A "Bit" is a basic piece of information. By a stepping circuit that keeps asking questions that can be answered by "yes" or "no" (a circuit ON or OFF), information can be gathered and stored. The systems shown are basic building blocks. (*From new 60-page bound catalog, Femco, Inc., Irwin, Pa.*)

For this literature circle **405** on inquiry card.

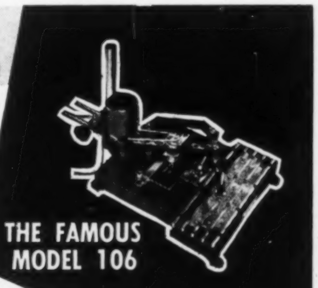
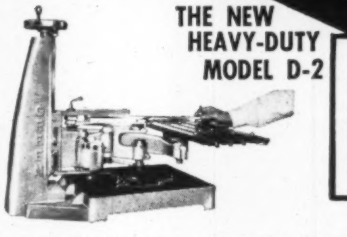
WINZELER
Stamped Gears

GET THIS FREE
STAMPED GEAR GUIDE!

SEND TODAY *for useful 4-page folder . . a valuable guide to all that is best in the mass production and use of low-cost Stamped Gears, Tools and Assemblies. Many various types are described. Also contains technical data, tables, ideas, suggestions. Use company stationery, please!*

WINZELER MANUFACTURING & TOOL CO.
1712 WEST ARCADE PLACE, CHICAGO 12, ILLINOIS

For more information circle **98** on inquiry card.


THE FAMOUS MODEL 106

THE NEW HEAVY-DUTY MODEL D-2
unique in design — rugged in construction

GREEN
PANTOGRAPH
ENGRAVERS

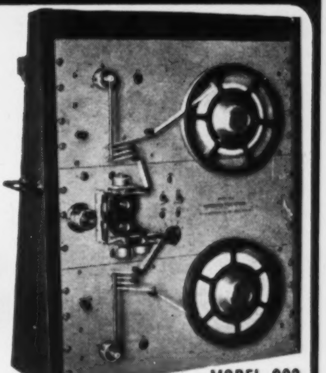
The three-dimensional bench Model 106 cuts costs — engraves, routs, models and profiles, giving you expert results even by unskilled workers.

The Model D-2 two dimensional heavy-duty Pantograph is a precision machine with a multitude of new features. Open on three sides, it permits complete freedom for engraving, milling, profiling large panels (up to 30" in diameter) or bulky pieces. Single, micrometer adjustment controls vertical depth of cut, automatically adjusting copy table with pantograph. Range of reduction ratios from 2-to-1 to infinity! Vertical range over 10 inches!

For complete information, write to

GREEN INSTRUMENT COMPANY
383 Putnam Ave. Cambridge, Mass.

For more information circle **97** on inquiry card.



reads up to 600 characters/sec!

STOPS ON A CHARACTER!

Potter

New, Unique
PERFORATED TAPE READER
with take-up reels

- Character Reading Speeds of 600, 300 or 150 per second.
- Five millisec start time.
- Simple Photo-Diode Reading Head.
- Bi-directional.
- Easy to thread.
- Reads 5, 6, 7 or 8 level perforated tape.
- Long tape life through use of low tension photoelectric servo.
- Remote control by pulses.
- Tape Drive and start-stop mechanism available separately for tape loop and basket applications.

For complete information write or call

Potter
POTTER INSTRUMENT COMPANY, INC
115 Cutter Mill Road · Great Neck, N. Y.

For more information circle **99** on inquiry card.

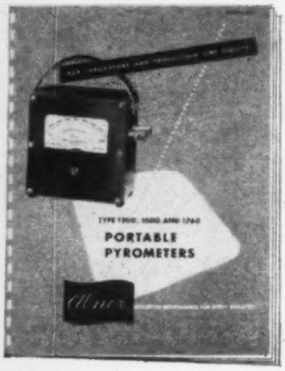
get this

FREE

illustrated bulletin

Learn how easy it is for anyone to read temperatures up to 3000 F. with

ALNOR PORTABLE PYROMETERS



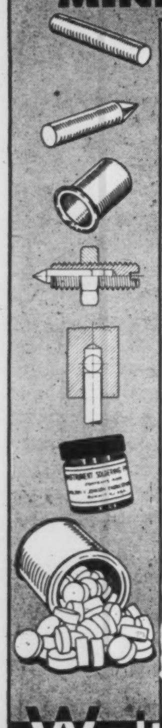
Wherever heat measurement is a problem—in the laboratory, shop, or in the field—you'll find the completely self-contained, portable Alnor Pyrometer the economical answer. Product of skilled, specialized instrument craftsmen, an Alnor will provide the consistent accuracy for all jobs—and at a cost of less than $100.00.

Get your copy of Bulletin 4434 now!
Send this ad on your letterhead to:
Illinois Testing Laboratories, Inc.
Room 518, 420 No. La Salle Street,
Chicago 10, Illinois.

Alnor

PRECISION INSTRUMENTS
FOR EVERY INDUSTRY

For more information circle **100** on inquiry card.



MINIATURE PARTS

CUSTOM MANUFACTURE OF SMALL PARTS

- Shafts, Staffs and Pivots of Special Pivot Steel, Heat-Treated and Metallographic-Polished. • Tubular Products up to 3/8" Diameter, Cut, Flared, Swaged, Formed and Burr-Free Alloy or Silver Plated. • Screw-Machine Products up to 3/16" Diameter. • Roll-Threading and Knurling to Close Tolerances. • Centerless and Surface Grinding with Special Facilities for Ceramic Rods and Shapes. • Light Punch-Press Work.

SERVICES FOR CUSTOMERS' PARTS

- A Multitude of Services are Available for Customers' Parts at Any Stage of Manufacture. These Include: Controlled-Atmosphere Heat-Treating, Centerless Grinding, Surface Grinding, Knurling, Thread-Rolling, Swaging, Drilling, Milling, Burr Removing, Metallographic, Polishing, Barrel-Plating in Alloy or Silver.

ASSEMBLY SUPPLIES

- "Welton" Non-Corrosive Instrument Solder Paste. • "Weltonoil" Treated Buttonwood Pith.

APPARATUS DESIGN SERVICES

In Connection with the Design and Fabrication of Precision Miniature Parts.

ENGINEERING ASSISTANCE ON ALL ITEMS

Welton V. Johnson
ENGINEERING COMPANY INC.
87 SUMMIT AVENUE • SUMMIT, N. J.

For more information circle **101** on inquiry card.

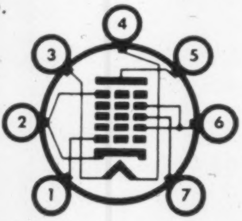
BRIEFS—CONTINUED

High-speed Computer Tubes

General Electric produced the first tube designed expressly for binary counter or "flip-flop" service. The first tube in this line, Type GL-5844, was announced in 1951 . . . One computer manufacturer with more than a million GL-5844 tubes in service reports a failure rate of 0.2 percent per 1,000 hours. In 1952, another twin triode, Type GL-5965 was announced by GE . . . A third, GL-6463, was added in mid-1954 . . . The most recent additions to the line of GE computer tubes, GL-6211 and -5915-A, were announced later in 1954. (*From new 52-page Catalog ETD-1140 "G-E Computer Tubes and their Applications, General Electric Tube Dept., Schenectady 5, N. Y.*)

GL-5915-A

Dual-control heptode for use primarily as a coincidence-gating tube.



For this literature circle **406** on inquiry card.

Potentiometer Resolution

This paper describes and defines the various types of potentiometer resolution for which some standardization has been accomplished. Several methods of measuring and analyzing these forms are discussed. Shorting resolution,

ENGINEERS

Creative Opportunities with Republic Aviation

Research

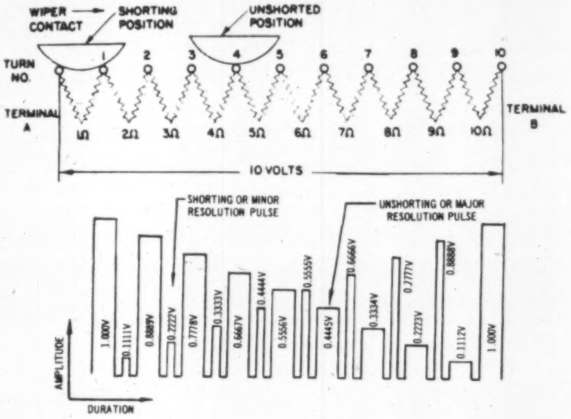
Vibration Engineer

Two to five years aircraft vibration experience required. Shock and vibration theory and a practical knowledge of electro-mechanical shaker application as used in experimental research testing of complete airframes for flutter analyses and component investigation essential. Familiarity with usage of accessory electronic instrumentation equipment desired. Graduate with M.E. or A.E. degree preferred.

Please address complete resume, outlining details of your technical background, to:
Assistant Chief Engineer
Administration
Mr. R. L. Bortner

REPUBLIC AVIATION
FARMINGDALE, LONG ISLAND, NEW YORK

or the "shorting effect" of the brush is described and illustrated and a distinction between normal, shorting and unshorting resolution is made. Effects of contact width, high wires, broad spacing of resistance wire turns, and speed of rotation on potentiometer resolution is discussed and illustrated. Resolution as an important factor in determining potentiometer linearity and conformity is discussed and a number of design criteria are established. Limits of resolution for various types of potentiometers


WIPER CONTACT
SHORTING POSITION
UNSHORTED POSITION
TURN NO.
1
2
3
4
5
6
7
8
9
10
TERMINAL A
TERMINAL B
1Ω
2Ω
3Ω
4Ω
5Ω
6Ω
7Ω
8Ω
9Ω
10Ω
10 VOLTS
SHORTING OR MINOR RESOLUTION PULSE
UNSHORTING OR MAJOR RESOLUTION PULSE
1.000V
0.1111V
0.8889V
0.2222V
0.7778V
0.3333V
0.6667V
0.4444V
0.5556V
0.5555V
0.4445V
0.6666V
0.3334V
0.7777V
0.2223V
0.8888V
0.1112V
1.000V
AMPLITUDE
DURATION

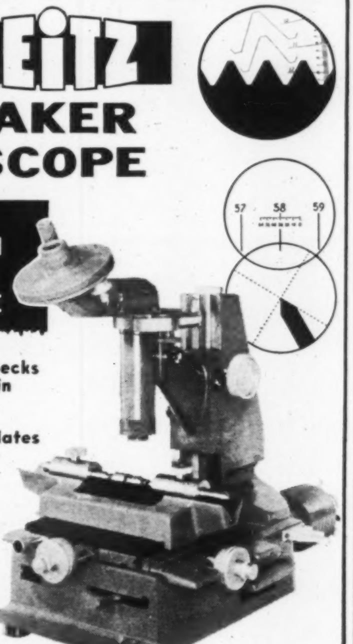
are given and several potentiometer design limitations imposing restrictions on resolution are cited. Infinite resolution potentiometers of the deposited metal film type are briefly discussed. (*From new 12-page brochure, "Resolution in Precision Wire-Wound Potentiometers," by R. J. Sullivan, Fairchild Camera & Instrument Corp., Hicksville, N. Y.*)

For this literature circle **407** on inquiry card.

NEW LEITZ

TOOLMAKER MICROSCOPE

...PRODUCES HIGHEST PRECISION ....CUTS INSPECTION TIME



The NEW LEITZ DESIGN checks angular measurements in degrees and minutes.

Contains all Thread Templates for U. S. National thread profiles 6-80 pitch.

Contains Radii Templates from 21/64" to 13/16" by 1/64". Concentric circles from .010" to .280" by .010" and one blank compartment.

NOTE: TEMPLATES CAN BE OBSERVED IN 3 MAGNIFICATIONS: 10X - 20X - 30X

BE SAFE — SEND FOR LATEST BULLETINS

Geo. SCHERR OPTICAL TOOLS, Inc.
200-MG LAFAYETTE STREET • NEW YORK 12, N. Y.

For more information circle **103** on inquiry card.

Quality **SMALL TUBING**
in COPPER and COPPER BASE ALLOYS

- ★ THIN WALL Tubing
- ★ BRAIDED Tubing
- ★ CAPILLARY Tubing
- ★ BOURDON Tubing
- ★ SHAPE Tubing

For *better* measurement and control in Industrial Instruments

Since 1909 we have specialized in the manufacture of seamless bourdon and capillary gauge tubing for instruments, gauges, pressure control and recording equipment, and for applications requiring tubing of accurate gauge and fine finish.

Years of manufacturing experience, plus modern mill equipment, rigid production and laboratory control assure both excellence and uniformity in every foot of tubing for maximum production and efficiency.

Quality **SMALL TUBING**
in COPPER and COPPER BASE ALLOYS
Write for Catalog MW-A

THE MACKENZIE WALTON CO.
PAWTUCKET • RHODE ISLAND
Sales Representatives: COREY STEEL COMPANY
2800 South 61st Court Chicago, Illinois

For more information circle **104** on inquiry card.

TYPE
TIMING
COIL
NO.
MIN.
SEC
AGASTAT
TIME DELAY

AGASTAT

Compact . . . Dust-Proof
TIME DELAY RELAYS
solenoid actuated—pneumatically timed

Introduces time delays into a-c or d-c circuits. Easily adjusted to provide delays ranging from 0.1 second to five or more minutes.

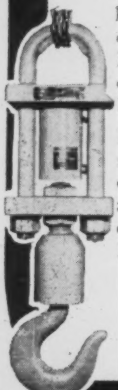
The AGASTAT is small, light, and operates in any position. Dust-proof timing chamber assures long operating life with a minimum of maintenance.

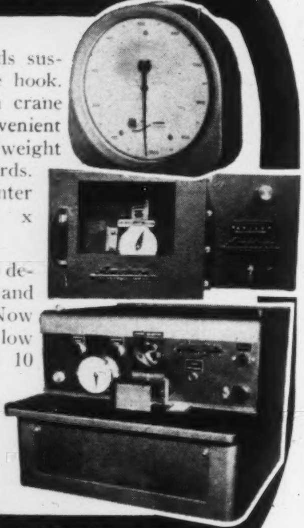
AGA DIVISION

Elastic Stop Nut Corporation of America
1027 Newark Avenue, Elizabeth, New Jersey
Dept. A15-69

For more information circle **105** on inquiry card.

Ametron® ELECTRONIC CRANE SCALE





Weighs heavy loads suspended from crane hook. Printer, located in crane cab or other convenient location, records weight on tape or cards. New compact printer only 22" x 18" x 10½".

Entire assembly designed for prompt and easy installation. Now available at new low cost. Capacities 5 10 15 tons

Write for free Ametron Brochure K-5

STREETER-AMET CO.
4101 N. RAVENSWOOD AVENUE
CHICAGO 13, ILLINOIS
Branches in
Detroit, Pittsburgh, Allentown, Birmingham and Los Angeles

THE STANDARD OF ACCURACY SINCE 1888

For more information circle **106** on inquiry card.

For Accurate Measurement of Elapsed Time Intervals

Cramer
TIME TOTALIZERS
THE R. W. CRAMER COMPANY INC.
RUNNING TIME METER
SECONDS
CENTERBROOK, CONN.

Type 640E
Running Time Meter

Type 690
Time Totalizer

CRAMER TIME TOTALIZERS

- *Electrical Stop Clocks*
- *A complete line of Running Time Meters*

Wherever time must be accurately measured and accumulated. Write for Bulletin PB-610.

SPECIALISTS IN TIME CONTROL

Cramer TIMING DEVICES

The R. W. CRAMER CO., Inc.

BOX 5, CENTERBROOK, CONNECTICUT

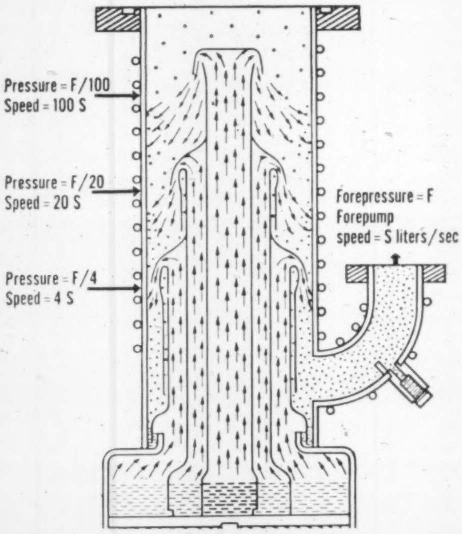
12CR55

For more information circle **107** on inquiry card.

Diffusion Pumps

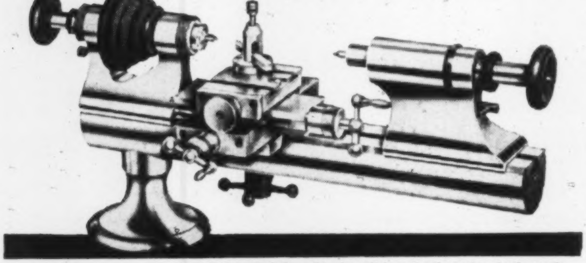
"High vacuum" is a term meaning many things to many people. . . . In a mass spectrometer, pressures approaching 10^{-7} mm Hg are needed.

Today's standard, basic tool for creating the highest vacuum is the oil diffusion pump. It consists primarily of a water-cooled jacket containing a suitable boiler-and-jet combination and a quantity of specially compounded pump fluid. Since the fluid is the only moving part of a diffusion pump, requirements for it are very rigid: it must be chemi-



SMALL INSTRUMENT PARTS ARE MADE BEST ON LEVIN® LATHES

Twenty-three models for all types of work. 4" swing, Bed Length 12" or 18"; over 100 stock sizes of collets from .004" to 5/16".



Send for Catalog M describing Lathes for tool work, second operations; turrets and full line of accessories.

LOUIS LEVIN & SON, INC., 3610 S. Broadway, Los Angeles 7, Calif.

For more information circle **108** on inquiry card.

cally and thermally stable and possess exactly the right vapor-pressure characteristics for its application.

The pump's action is analogous to that of a heavy rainstorm in washing dust from the atmosphere, since its action depends on the collision and entrainment of random particles by more numerous, rapidly moving particles traveling in a single, directed course. As the pump fluid is boiled, its molecules rise as a hot vapor and are emitted through jets which force them downward and outward at supersonic speeds. Air molecules entering the jet region are bombarded by the heavier pump-fluid molecules and propelled downward. The air is thus compressed in the lower part of the pump and can be removed through a foreline, while the pump-fluid vapor condenses on the cooled wall and returns as a liquid to the boiler, where it repeats the cycle as long as the heating element is active. (*From 28-page Vol. 8 No. 1 issue of "CEC Recordings," Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.*)

For this literature circle **408** on inquiry card.

Corona, Hipot Testing

Previous methods using a neon lamp as a leakage indicator (in hipot testing) required at least 500 microamperes to provide positive indication of leakage . . This frequently destroyed the component. The limited current of the "H" series of Hipots plus the fast electronic circuit breaker with 5 microamp sensitivity makes these units truly nondestructive.

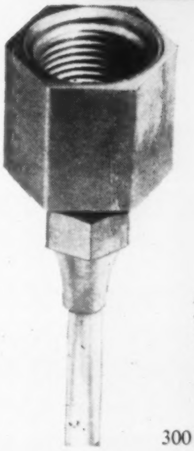
Method of making corona test: 60 cycle ac is applied gradually to the specimen under test. Detection of the starting point of corona is made by a network which feeds pulses to a detector and oscilloscope . . . increase in applied voltage should be stopped as soon as scope shows first trace of corona. Panel kilovoltmeter should then be read. (*From new 8-page* 1955 *Catalog, Peschel Electronics, Inc.,* 13 *Garden St., N. Rochelle, N. Y.*)

For this literature circle **409** on inquiry card.

Here's a pressure pickup made specifically for hydraulic work . . . CEC's new 4-314. Its ¾-16 AN threads, O-ring and hex head make direct, in-line installation a quick, sure procedure.

And it's blowout-proof to 10,000 psi!

Just seconds to install!

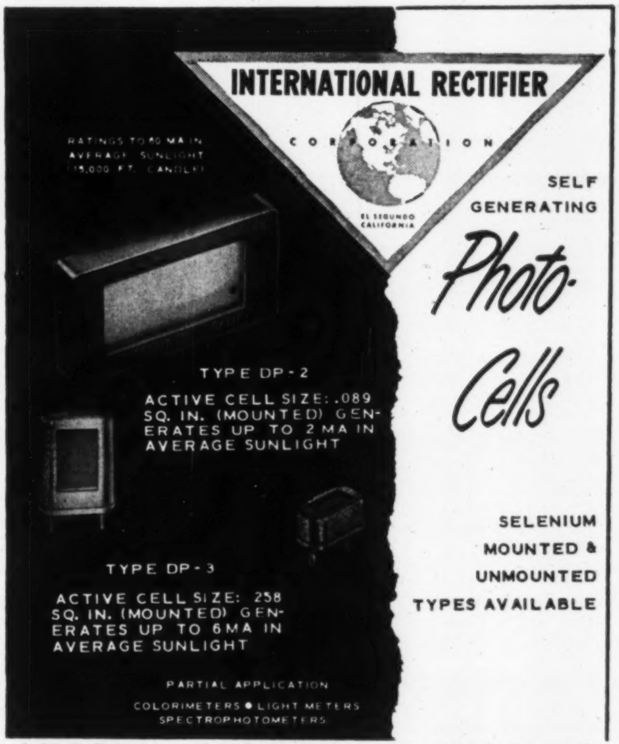


Pressure ranges..1000, 2000, 3000, 5000 psi (absolute or gage)
Sensitivity....20 mv f.s. @ 5-volt excitation
Excitation....5 v d-c or a-c rms, 0-20 kc
Input/output impedance....350 ohms
Linearity....1% f.s. max. deviation
Hysteresis....less than 1% of f.s.
Acceleration response....less than 0.01% of f.s. per g
Construction....416 stainless steel
Electrical connection....four numbered pin terminals
Size....1-5/32-inch length, 1-inch hex head
Weight....55 grams

A *complete* calibration certificate sent with every unit. Send for Bulletin CEC 1553-X 6

Consolidated Engineering
CORPORATION
300 N. Sierra Madre Villa, Pasadena 15, Calif.

For more information circle **110** on inquiry card.



INTERNATIONAL RECTIFIER
CORPORATION
EL SEGUNDO CALIFORNIA

RATINGS TO 80 MA IN AVERAGE SUNLIGHT (15,000 FT. CANDLE)

SELF GENERATING
Photo-Cells

TYPE DP-2
ACTIVE CELL SIZE: .089 SQ. IN. (MOUNTED) GENERATES UP TO 2 MA IN AVERAGE SUNLIGHT

TYPE DP-3
ACTIVE CELL SIZE: 258 SQ. IN. (MOUNTED) GENERATES UP TO 6MA IN AVERAGE SUNLIGHT

SELENIUM
MOUNTED &
UNMOUNTED
TYPES AVAILABLE

PARTIAL APPLICATION
COLORIMETERS ● LIGHT METERS
SPECTROPHOTOMETERS

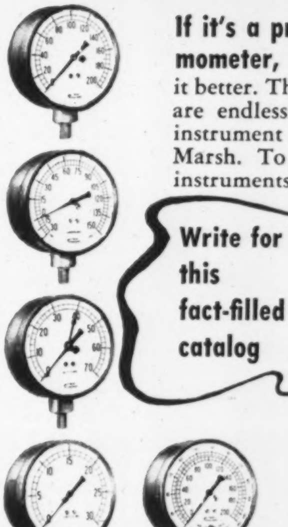
INTERNATIONAL RECTIFIER
CORPORATION
1521 E. Grand Ave., El Segundo, Calif · Phone: ORegon 8-6281
CHICAGO: 205 W. Wacker Drive · Phone: Franklin 2-3889
NEW YORK: 501 Madison Avenue · Phone: Plaza 5-8665

For more information circle **109** on inquiry card.

MARSH MAKES IT!

If it's a pressure gauge or dial thermometer, Marsh makes it . . . and makes it better. The types, ranges and case styles are endless. What is "special" to other instrument makers is often standard to Marsh. To know the scope of Marsh instruments—

Write for this fact-filled catalog



MARSH
Gauges Thermometers
catalog no.
UO-W

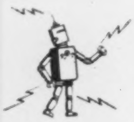
MARSH INSTRUMENT CO.,
Sales affiliate of Jas. P. Marsh Corporation,
Dapt. 42, Skokie, Ill. *Export Dept.,* 3501 Howard St., Skokie, Ill.
Marsh Instrument & Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alta.

For more information circle **111** on inquiry card.

New Literature...

INSTRUMENTS and AUTOMATION

For literature use the postage-free order card on page 1017.



AUTOMATION

Control Systems. New 14-page Bulletin S-10 presents case histories of design, construction, and start-up of packaged automatic control systems using diff.-transformers, time control, process controllers, etc.—Automatic Temperature Control Co., Inc., 5200 Pulaski Ave., Philadelphia 44, Pa.

Circle **410** on inquiry card.

Process Control. New 2-page Bulletins (4100, 7400, 3500, 2030 & 2050, 3100, 1200 & 1210, 7500, 1100 & 1110, 1500 & 1510, 1650, 7301, and 2200) present price lists for maker's "Probotrol" probe control, alarm silencer, "Selectrols," "L" float switches, "Floatrols," "Mototrols," "hi-level" safety switch, "Tanktrols," "Duotrols," "Bubbltrols," "Motorelay," and "C & R" float switches.—Automatic Control Co., 1005 University Ave., St. Paul 4, Minn.

Circle **411** on inquiry card.

Millivoltmeter Controller. New 16-page bulletin describes application of maker's "Series 400 Capacitrol" d'Arsonval-type millivoltmeter controllers for process control.—Barber-Colman Co., Wheelco Instruments Div., Rockford, Ill.

Circle **412** on inquiry card.

Load Controller. New 2-page Bulletin F 5726-1 describes maker's "Inputrol" for automatically controlling input rate of electrical power.—Barber-Colman Co., Wheelco Instruments Div., Rockford, Ill.

Circle **413** on inquiry card.

Process Control. Three new 4-page Bulletins I-N-1, T-5, and T-7 describe maker's pressure and temperature controllers, interval timers, and timing pushbutton for control of time interval.—Seely Instrument Co., Inc., Niagara Falls, N. Y.

Circle **414** on inquiry card.

Contact Controllers, Pyrometers. New 2-page Bulletin 108 describes and illustrates maker's sensitive relays and plug-in assemblies for automatic control circuits. 4-page Bulletin G-8 covers standard ranges and specifications of "Simplytrol" automatic pyrometers for control of temperature in furnaces and ovens.—Assembly Products, Inc., Chesterland, Ohio.

Circle **415** on inquiry card.

Control System Design. New 4-page Bulletin V-4002 presents detailed steps involved in designing a control system for accuracy, resolution, and frequency response by use of simulation.—CDC Control Services, Inc., 400 S. Warminster Rd., Hatboro, Pa.

Circle **416** on inquiry card.

Process Control. New 2-page Bulletin 954 describes maker's self-operated temperature controllers, air-operated recording, indicating and non-indicating controllers, electrically-operated controllers, and diaphragm motor valves.—Century Instrument Co., 565 E. Milwaukee Ave., Detroit 2, Mich.

Circle **417** on inquiry card.

Autronic Control. New 4-page Bulletin A1.3-1 presents description of function and working principles of each unit in "Autronic" electronic process control system.—Swartwout Co., 18511 Euclid Ave., Cleveland 12, Ohio.

Circle **418** on inquiry card.

Process Instrumentation. New 28-page issue of "Taylor Technology" (Vol. 7, No. 3) features articles on "Instrumenting a Nylon Intermediates Plant, Wax Recovery from Sugar Cane," etc.—Taylor Instrument Companies, Rochester 1, N. Y.

Circle **419** on inquiry card.

Combustion Control. New 22-page combustion controls catalog describes and illustrates maker's damper controls, cut-off switches, drive units, smoke indicators, etc.—Cleveland Fuel Equipment Co., 1111 Brookpark Rd., Cleveland 9, Ohio.

Circle **420** on inquiry card.

Electronic Machine Control. New 4-page brochure "Automatic Electrolytic Shaping With Electronic Control" points out that standard grinders with electronic control increases efficiency while saving 90 percent in diamond wheel costs.—Anocut Engineering Co., 531 W. Washington Blvd., Chicago 6, Ill.

Circle **421** on inquiry card.

VALVES

Valve Sizing. New 24-page booklet describes and illustrates maker's test-proven method of sizing control valves and regulators.—Black, Sivalls & Bryson, Inc., 15 N. Cincinnati, Tulsa 1, Okla.

Circle **422** on inquiry card.

Servo Valves. New 4-page Bulletin 2000 describes maker's "Model 2000" dry solenoid servo valves for high-performance electro-hydraulic positional-type servo systems.—Moog Valve Co., Inc., E. Aurora, N. Y.

Circle **423** on inquiry card.

Control Valves. New 4-page illustrated Bulletin 103-B describes maker's "Ultravalve" diaphragm motor control valve for controlling pressure, temperature, liquid level, humidity or pH.—Hammel-Dahl Co., 175 Post Rd., Providence 5, R. I.

Circle **424** on inquiry card.

Control Valves. New 4-page Bulletin 104 describes and illustrates maker's "Series 700 Venturiflow" angle diaphragm control valves for gas and oil well separators, high-pressure gas transmission lines, etc.—Hammel-Dahl Co., 175 Post Rd., Providence 5, R. I.

Circle **425** on inquiry card.

Control Valves. New 4-page Bulletin 101B pictures and describes maker's "Flash-Flow" plug to minimize flashing and erosive effects of high pressure drop.—Hammel-Dahl Co., 175 Post Rd., Providence 5, R. I.

Circle **426** on inquiry card.

Angle Valves. New 6-page Bulletin 104-B describes maker's "Venturiflo" angle valves for handling viscous fluids, slurries and dirty solutions.—Hammel-Dahl Co., 175 Post Rd., Providence 5, R. I.

Circle **427** on inquiry card.

Valves. New 4-page Bulletin 104-A pictures and describes maker's "Series 7000 Barstock" angle diaphragm control valves for pressure ratings of 3000 and 7500 psi at 100 F.—Hammel-Dahl Co., 175 Post Rd., Providence 5, R. I.

Circle **428** on inquiry card.

Valves. New 4-page Bulletin V-1 illustrates and describes maker's line of valves—bleeder check, boiler feedwater, venturi reducing, heater bypass, balanced butterfly, and atmospheric relief; also high-pressure forged-strainer.—Schutte and Koerting Co., Cornwells Heights, Bucks County, Pa.

Circle **429** on inquiry card.

Shut-off Valve. New 4-page Bulletin 132-D4-1 describes and illustrates maker's automatic shut-off valve that stops flow when shut-off pressure is reached.—Security Valve Corp., 541 W. Garfield, Glendale 4, Calif.

Circle **430** on inquiry card.

Metering Valve. New 2-page bulletin describes maker's leak-proof metering valve giving smooth positive control with gases or liquids.—Robbins Aviation, 1735 W. Florence Ave., Los Angeles 47, Calif.

Circle **431** on inquiry card.

Steam Trap. New 4-page Bulletin 255 describes maker's thermodynamic steam trap for pressures to 600 psi and temperatures to 950 F.—Sarco Co., Inc., Empire State Bldg., N. Y. 1, N. Y.

Circle **432** on inquiry card.

Ball Valves. New 6-page Folder V-10M-11-54 presents maker's ball valves that are leak proof, and open or close with ¼ turn.—Rockwood Sprinkler Co., 38 Harlow St., Worcester 5, Mass.

Circle **433** on inquiry card.

MOTORS, SERVOS

Synchros, Servo Motors. New 4-page Bulletin 355 presents specifications and characteristics of over 130 synchros, servo motors, and resolvers. —Norden-Ketay Corp., 99 Park Ave., New York 16, N. Y.

Circle **434** on inquiry card.

Servo Components. New set of 2- and 4-page Data Sheets (Nos. 10.20-1, 10.20-2c, 10.20-3b, 10.20-4, 10.20-5, and 10.20-6) describe and illustrate maker's 400-cycle converters, 60-cycle balancing motor, servo systems and components, servo amplifier system, converters for d-c signal input voltages, and "Elect-O-Vane" limit-switch-type control unit.—Minneapolis-Honeywell Regulator Co., Industrial Div., Philadelphia 44, Pa.

Circle **435** on inquiry card.

Motors. New 12-page Booklet 1856 describes and illustrates maker's "Type H" uniclosed motor having cast-iron frame, moisture-proof core, electronically-balanced solid cast rotor.—U. S. Electrical Motors, Inc., P. O. Box 2058, Los Angeles 54, Calif.

Circle **436** on inquiry card.

Motor Control. New 8-page Booklet 1882 describes maker's "Varitrol" pneumatic control that permits "Varidrive" motor speed to be controlled by pressure, temperature, humidity, viscosity, etc.—U. S. Electrical Motors, Inc., Box 2058, Los Angeles 54, Calif.

Circle **437** on inquiry card.

Motors. New Bulletin 2P2 pictures and describes maker's "SP-25" shaded-pole motor for high or low ambient temperatures.—Electric Motors & Specialties, Inc., King & Hamsher Sts., Garrett, Ind.

Circle **438** on inquiry card.

TEMPERATURE

Pyrometer Supplies. New 16-page catalog describes and illustrates maker's thermocouples, protecting tubes, tc wires, insulators, accessories and pyrometers.—Arklay S. Richards Co., Inc., Newton Highlands 61, Mass.

Circle **439** on inquiry card.

Pyrometers, Supplies. New 4-page Bulletin DM037 describes and illustrates maker's thermocouple and pyrometer supplies.—Bristol Co., Waterbury 20, Conn.

Circle **440** on inquiry card.

Surface Thermometer. New 2-page bulletin pictures and describes maker's "Pandux" surface thermometer for plates, pipes, molds, etc.—Pacific Transducer Corp., 11836 W. Pico Blvd., Los Angeles 64, Calif.

Circle **441** on inquiry card.

Panel Indicators, Pyrometers. New 8-page Bulletin G-9 presents specifications of maker's "Sim-Ply-Trol" indicating d'Arsonval-type pyrometers, "Gradutemp" oven thermometer, millivoltmeter, etc.—Assembly Products, Inc., Chesterland, Ohio.

Circle **442** on inquiry card.

Temperature Systems. New 4-page Bulletin 126 describes maker's high-accuracy temperature indication systems for aircraft jet engines.—Avien, Inc., 58-15 Northern Blvd., Woodside 77, N. Y.

Circle **443** on inquiry card.

New!

"P" TYPE
ENCAPSULATED
RESISTORS

Stable... Small... Light-weight...

Shallcross "P" Type Encapsulated Resistors are ideal for installation where stability, dependability, and minimum size and weight are a must. These radically new resistors offer the performance advantages of hermetically-sealed steatite resistors at less cost.

Because of the unique Shallcross method of encapsulating windings, "P" type resistors have greater maximum resistances, longer leakage paths, and higher wattage ratings.

Shallcross "P" type resistors are available in six MIL-R-93A lug-type styles and five axial lead styles with wattage ratings ranging from .500 to 3.5 watts. All styles meet and exceed JAN-R-93A, Characteristic A.

Complete information on sizes, ratings, and test results of Shallcross "P" type precision wirewound resistors is available in Engineering Bulletin L-30. Write for your copy today.

SHALLCROSS MANUFACTURING CO.
510 Pusey Avenue, Collingdale, Pa.

Shallcross

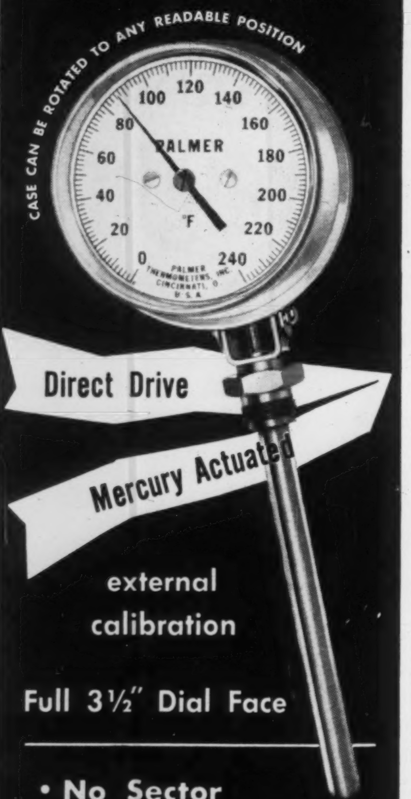
For more information circle **112** on inquiry card.

PALMER

presents

an outstanding improvement in

DIAL THERMOMETERS


CASE CAN BE ROTATED TO ANY READABLE POSITION
0
20
40
60
80
100
120
140
160
180
200
220
240
PALMER
°F
PALMER THERMOMETERS, INC. CINCINNATI, O. U.S.A.
Direct Drive
Mercury Actuated

external calibration

Full 3½" Dial Face

- No Sector
- No Pinion
- No Linkage
- Constant Accuracy
- Easy Readability

WRITE FOR BULLETIN 350

PALMER

THERMOMETERS, INC.

Norwood Ave., Cincinnati 12, Ohio
Mfrs. of Industrial Laboratory Recording and Dial Thermometers

For more information circle 113 on inquiry card.

NEW LITERATURE

Combustion Safeguards. New 4-page issue of "Wheelco Comments" (Vol. 15, No. 2) pictures and describes maker's "Flame-otrol" electronic combustion safeguard.—Barber-Colman Co., Rockford, Ill.

Circle **444** on inquiry card.

Temperature Control. New 8-page Bulletin F 6149-2 describes application of automatic control in industrial processes. Includes control terminology, pickups, and various types of controllers.—Barber-Colman Co., Wheelco Instruments Div., Rockford, Ill.

Circle **445** on inquiry card.

TC Assemblies. New 20-page Catalog 1542 describes and illustrates maker's thermocouple assemblies and pressure sealing glands.—Conax Corp., 7811 Sheridan Dr., Buffalo 21, N. Y.

Circle **446** on inquiry card.

TC Amplifier. New 4-page bulletin describes and illustrates maker's low-frequency (2-20 cps) high-gain amplifier and regulated power supply for use with thermocouples, thermopiles, etc.—Farrand Optical Co., Inc., Bronx Blvd. & E. 238th St., New York 70, N. Y.

Circle **447** on inquiry card.

Injector Burners. New Bulletin H-63T describes and illustrates maker's "Walltite" injector burners for high pressure gas.—Eclipse Fuel Engineering Co., 1001 Buchanan St., Rockford, Ill.

Circle **443** on inquiry card.

Temperature Control. New Bulletin 754 describes maker's "Series 3070" self-operated controllers for controlling temperatures of plating and cleaning tanks, storage water heaters, fuel oil preheaters, etc.—Century Instrument Co., Detroit 2, Mich.

Circle **449** on inquiry card.

Thermostats. New 4-page brochure describes and illustrates maker's "Temp-Guard" thermostats and motor protectors.—The Franklin Dales Co., 180-184 E. Mill St., Akron, Ohio.

Circle **450** on inquiry card.

PRESSURE

Differential-pressure Switch. New 4-page Bulletin 211-1 presents specifications, operating characteristics and outline dimensions of maker's differential-pressure switch for control and indication of flow, liquid level and differential pressure.—Barton Instrument Corp., 1429 S. Eastern Ave., Los Angeles 22, Calif.

Circle **451** on inquiry card.

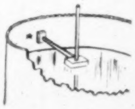
Pressure Pickup. New 2-page Bulletin CEC-1556 describes and illustrates maker's "Type 4-315" differential-pressure pickups with ranges of ±1, 2, and 3 psi.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

Circle **452** on inquiry card.

Pressure Gages. New 4-page Bulletin BJE-606 pictures and describes maker's "Vibrotron" miniature variable-frequency transducer for measuring static and dynamic pressures.—Byron Jackson Co., 2010 Lincoln Ave., Pasadena 3, Calif.

Circle **453** on inquiry card.

LEVEL



Level Control Valves. New 16-page Catalog 107 describes and illustrates maker's float and lever valves for installation above liquid level.—Schade Valve Mfg. Co., 2527-37 N. Bodine St., Philadelphia 33, Pa.

Circle **454** on inquiry card.

Liquid Level. New 2-page Data Sheet 263 illustrates and describes maker's improved liquid level gage illuminators that provide diffusion of light over entire gage length. 2-page Data Sheet 245A presents line of high-pressure boiler-water gages.—Jerguson Gage & Valve Co., 87 Fellsway, Somerville 45, Mass.

Circle **455** on inquiry card.

Tank Gage. New 4-page Bulletin 501 illustrates maker's new "Magnalux" tank gage for liquid level, featuring leak-proof tank and permanent-magnet-float-follower pickup.—Liquidvision Gauge & Control Corp., P. O. Box 51, Oceanside, L. I., N. Y.

Circle **456** on inquiry card.

FLOW, PUMPS

Flowmeters. New 4-page Bulletin 285-G2A describes and illustrates maker's line of flowmeters for water and sewage plants.—Builders-Providence Inc., 345 Harris Ave., Providence, R. I.

Circle **457** on inquiry card.

Controlled-volume Pumps. New 24-page Bulletin 953 describes and illustrates maker's controlled-volume pumps and uses in water treating.—Milton Roy Co., 1300 E. Mermaid Lane, Philadelphia 18, Pa.

Circle **458** on inquiry card.

Pumps. New 6-page Folder 205 describes and illustrates maker's self-priming centrifugal pumps, end-suction pumps, electropumps and split-case pumps.—Carver Pump Co., Muscatine, Iowa.

Circle **459** on inquiry card.

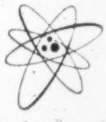
Compressors. New 6-page illustrated Bulletin 603 describes maker's line of air and gas compressors, dry-vacuum pumps, check valves, aftercoolers, and centrifugal pumps for handling water and aqueous solutions.—Pennsylvania Pump & Compressor Co., Easton, Pa.

Circle **460** on inquiry card.

Compressor. New 4-page Bulletin 1540 describes maker's "Model 20T" 20-hp air-cooled compressor.—Ingersoll-Rand, 11 Broadway, New York 4, N. Y.

Circle **461** on inquiry card.

RADIOACTIVITY



Rate Meter. New 8-page issue of "Nucleus" (No. 7) describes maker's radioactivity count rate meter used with geiger tubes, scintillation counters or in industrial applications for monitoring purposes.—Nuclear Instrument and Chemical Corp., 221 W. Erie St., Chicago 10, Ill.

Circle **462** on inquiry card.

Geiger Counters. New 2-page bulletins describe maker's "Bismo-Count" (Model EC-6), "Crysto-Count" (Model EC-9), "Hole-Count" (Model EC-7) and "Electro-Count" (Model EC-5) which read directly in mr/hr and counts per minute.—Electronic Counter Labs., Inc., 418 S. Pecan St., Los Angeles 33, Calif.

Circle **463** on inquiry card.

Radioactivity Scaler. New 4-page leaflet presents characteristics of maker's "Model 200" scaler with direct readout.—Radiation Instrument Development Lab., 2337 W. 67th St., Chicago 36, Ill.

Circle **464** on inquiry card.

OPTICS

Optical Instruments. New 72-page booklet "Leitz Optical Measuring Instruments" describes and illustrates maker's machine-tool microscope, screw micrometer ocular, telescopes, projecting apparatus, optical flats, optical gear-tooth caliper, etc.—George Scherr Optical Tools, Inc., 200 Lafayette St., New York 12, N. Y.

Circle **465** on inquiry card.

Periscopes. New 4-page Bulletin 301 pictures and describes maker's industrial periscopes for remote viewing.—Kollmorgen Optical Corp., 30 Church St., New York 7, N. Y.

Circle **466** on inquiry card.

Light Sources. New 2-page Data Sheet 30.10 describes maker's "Isolite" calibrated light standards.—U. S. Radium Corp., 535 Pearl St., New York 7, N. Y.

Circle **467** on inquiry card.

Infrared Glass. New 4-page Bulletin TDS-1000 describes and illustrates maker's "Servofrax" infrared lens and window glass used for bolometers, pyrometers, gas analyzers, and infrared systems.—Servo Corp. of America, 2020 Jericho Turnpike, New Hyde Park, N. Y.

Circle **468** on inquiry card.

Photoelectric Fabric Scanner. New 4-page leaflet presents maker's "Photobell" electronic fabric scanner for automatic inspection of products in warp knitting.—Photobell Sales Corp., 43 Vesey St., New York, N. Y.

Circle **469** on inquiry card.

Color Measurement. New 6-page issue of "Engineering Information Service" (Vol. 2, No. 2) features article on "Measurement of Monochrome TV Screen Color by Photoelectric Tristimulus Colorimetric Methods."—Sylvania Electric Products, Inc., 1100 Main St., Buffalo 9, N. Y.

Circle **470** on inquiry card.

Color Control. New 4-page bulletin describes and illustrates maker's "Models 100, 300 & 500 Trichrometer" for color quality control applications.—Kaye Development Co., 70 Prospect St., Stamford, Conn.

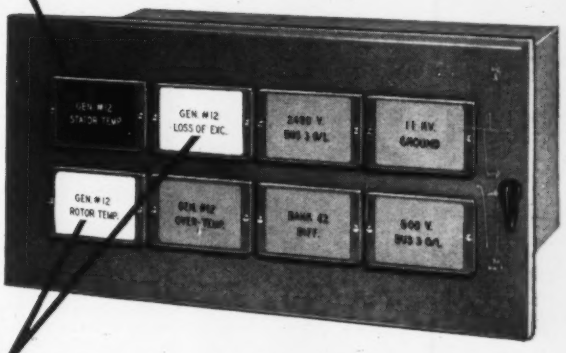
Circle **471** on inquiry card.

A DOUBLE BARRELLED TROUBLE SHOOTER

PANALARM "50VS"

VISUAL SEQUENCE ANNUNCIATOR*

1 **VISUALLY INDICATES**
first "off-normal" and subsequent "off-normals".



2 **SEQUENTIALLY GROUPS**
related variables for easy interpretation.

Troubleshooting in complex processes can be expensive and time consuming. The Panalarm "50VS" Visual Sequence Annunciator *eliminates guesswork . . . pinpoints trouble.* It immediately flashes the cause of trouble; instantly shows resultant "off-normals", and provides a means of grouping and acknowledging related variables so that minimum interpretation is required . . . quick, direct corrective action can be immediately taken.

Your present Universal Panalarm "50" Annunciator System can be changed to provide visual sequence signals. This flexibility prevents obsolescence . . . has made the Panalarm "50" the most versatile audio-visual annunciator available today.

PANALARM "50VS" gives CONTROL INFORMATION

- **The primary cause of trouble . . .**
- **Secondary "off-normals" resulting . . .**
- **Sequential follow-up of "off-normal" . . .**

Send for Bulletin 6-A.
LISTED BY
UNDERWRITERS'
LABORATORIES

PANALARM
Alarm and Safety Division

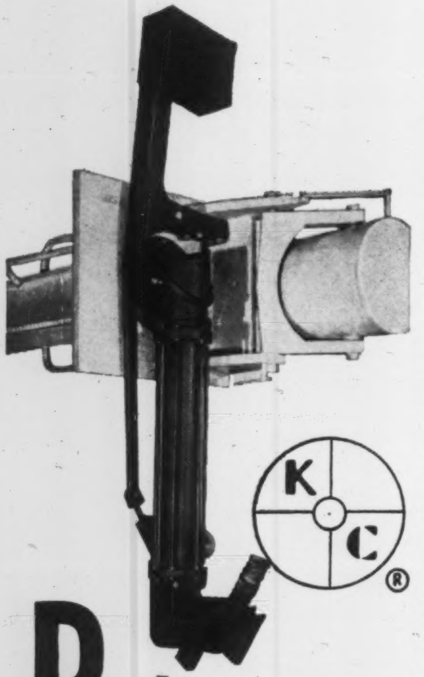
PANELLIT, INC.

7405 N. Hamlin Avenue, Skokie, Illinois

PANALARM
PANELLIT

*U.S. Patent No. 2701872 Copyright 1955, Panellit, Inc.

For more information circle **114** on inquiry card.



Periscopes

For

"HOT SPOT"

Remote Observation

A custom designed industrial periscope is very often the answer to "Hot Spot" remote control handling, instrumentation and observation. We have designed and manufactured many such periscopes.

If you have a problem calling for a periscope or for any precision optical system, check with us. For nearly half a century Kollmorgen has designed, developed and manufactured precision optical products including Industrial and Naval Periscopes, Fire Control Devices, Projection Lenses and Navigational Instruments for Industry and for the Armed Services.

Send for Bulletin 301

KOLLMORGEN Optical CORPORATION

Plant: 347 King Street, Northampton, Mass.
New York Office:
30 Church Street, New York 7, New York

For more information circle 115 on inquiry card.

NEW LITERATURE

RECORDING

Recording System. New 4-page Bulletin S-307 (P) describes maker's "MagneDISC" recording system featuring 50 channels on an 18.75-inch-diam. oxide-coated magnetic disc.—Houston Technical Labs., 2424 Branard, Houston 6, Texas.

Circle **472** on inquiry card.

Oscillogram Processor. New 4-page Bulletin 1537 C describes and illustrates maker's "Type 23-109" oscillogram processor, a portable "darkroom" for automatic, rapid, daylight operation.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

Circle **473** on inquiry card.

Amplifier System. New 8-page Bulletin 1403D describes and illustrates maker's "System D" high-gain, lightweight, reliable, precision amplifier system for use as a companion unit to recording oscillographs.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

Circle **474** on inquiry card.

Oscillograph. New 4-page bulletin describes and illustrates maker's "Model 581" 14-channel oscillograph designed for rugged flight-test work.—Midwestern Instruments, P.O. Box 7186, Tulsa, Oklahoma.

Circle **475** on inquiry card.

Recording Charts. New Stock List 106 1-55 covers maker's 3,000 most widely used "Permocharts" all-plastic instrument charts.—Allegheny Plastics, Inc., Thorn Run Rd., Coraopolis, Pa.

Circle **476** on inquiry card.

Autopositive Paper. New folder contains set of bulletins that present suggested uses for "Kodagraph Autopositive" paper which protects original engineering drawings, reclaims old drawing, improves legibility of prints, etc.—Graphic Reproduction Sales Div., Eastman Kodak Co., Rochester 4, New York.

Circle **477** on inquiry card.

COMPUTING, DATA HANDLING

Computer Tubes. New 50-page Booklet ETD-1140-P outlines company's computer tube program, presents data on five types in maker's line, reviews special computer tube design considerations and applications notes.—Tube Dept., General Electric, Schenectady 5, N. Y.

Circle **478** on inquiry card.

Digital Computer Elements. New 16-page booklet is article on symbolic logic, binary calculation, and "3C-PACs" (unitized gating circuits) for basic digital computer applications.—Computer Control Co., Inc., 92 Broad St., Wellesley 57, Mass.

Circle **479** on inquiry card.

Multiple Readout Systems. New 12-page Catalog 58-15 describes maker's multiple-pressure readout systems to speed up data handling for process industries, wind tunnels, engine test facilities, etc.—Fischer & Porter Co., 393 Jacksonville Rd., Hatboro, Pa.

Circle **480** on inquiry card.

Data Reduction. New 4-page bulletin describes and illustrates maker's "Datrac" data reduction systems featuring reversible analog-digital conversion, multiple-input reduction, simulation use, etc.—Epsco Inc., 588 Commonwealth Ave., Boston, Mass.

Circle **481** on inquiry card.

Punch Marking.—New 2-page data sheets describe and illustrate maker's "Kimball 75" punch marking machine for data and inventory control.—A. Kimball Co., 307 W. Broadway, New York 13, N. Y.

Circle **482** on inquiry card.

TIME, COUNT

Time Totalizers. New 8-page Bulletin PB-610 presents maker's "Type 690" electrical stop clock and "Types 630 and 640" running-time meters for operations control.—R. W. Cramer Co., Inc., Centerbrook, Conn.

Circle **483** on inquiry card.

Timing Control. New 2-page illustrated bulletin describes maker's "Type D494 Meritrol" timer giving automatic control of process or operation.—Emmett Machine & Mfg. Inc., 445 E. Turkeyfoot Lake Rd., Akron 19, Ohio.

Circle **484** on inquiry card.

Industrial Counters. New 2-page data sheets describe maker's line of unitized modular industrial counters and controls.—Atomic Instrument Co., 84 Massachusetts Ave., Cambridge 39, Mass.

Circle **485** on inquiry card.

Timing, Counting. New 8-page bulletin describes and illustrates maker's apparatus for timing, counting and recording, including mechanical stop watches, metronomes, electronic counters, etc.—C. H. Stoelting Co., 424 North Homan Ave., Chicago 24, Ill.

Circle **486** on inquiry card.

STRAIN, MOTION

Strain Gages. New 12-page Bulletin S-E 3-55 is 1955 price list for SR-4 strain gages, accessories, and cements. Includes specifications and suggestions for selection.—Baldwin-Lima-Hamilton Corp., Phila. 42, Pa.

Circle **487** on inquiry card.

Differential Transformer. New 2-page Bulletin LVDT-100A describes and illustrates maker's linear differential transformer for detection and measurement of minute linear mechanical displacement.—The Gudeman Co., 340 W. Huron St., Chicago 10, Ill.

Circle **488** on inquiry card.

VIBRATION, FREQUENCY

Vibration. New 2-page Bulletin CEC-1517 C describes and illustrates maker's "Coupling System B" compact, low-cost system for measurement of vibrational amplitudes in the 8-800-cps range.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

Circle **489** on inquiry card.

Tachometers. New 8-page Bulletin 770 describes "Standco" vibrating-reed tachometers for measuring rotational speeds on totally-enclosed equipment.—Herman H. Sticht Co., Inc., 27 Park Place, New York 7, N. Y.

Circle **490** on inquiry card.

Frequency Meters. New 4-page Bulletin 805 describes and illustrates maker's "Standco" vibrating-reed frequency meters.—Herman H. Sticht Co., Inc., 27 Park Place, New York 7, N. Y.

Circle **491** on inquiry card.

ULTRASONICS

Ultrasonics, Communications Equipment. New 32-page brochure presents facilities and personnel of manufacturer of military and industrial communications equipment, ultrasonic cleaning equipment, counting devices, etc.—Telephonics Corp., Huntington, Long Island, N. Y.

Circle **492** on inquiry card.

Ultrasonic Cleaner. New 4-page bulletin describes and illustrates maker's "Electrosonic" generator and filter transducer for industrial cleaning applications.—Telephonics Corp., Huntington, L. I., N. Y.

Circle **493** on inquiry card.

GAGING, TESTING

Tools, Gages. New 478-page Catalog 27 describes and illustrates maker's large line of steel tapes, steel rules, dial gages, hacksaws, micrometer calipers, height and depth gages, etc.—The L. S. Starrett Co., Athol, Mass.

Circle **494** on inquiry card.

Hydraulic Equipment. New 28-page Catalog describes and illustrates maker's hydraulic air booster for hydrostatic testing.—Century Hydraulics, Inc., 8866 Greenfield, Detroit 28, Mich.

Circle **495** on inquiry card.

Comparators. New 4-page brochure describes chart service for optical comparators.—Vanguard Instrument Corp., 184 Casper St., Valley Stream, N. Y.

Circle **496** on inquiry card.

Master Balls. New 8-page illustrated bulletin describes applications of maker's master balls in tool room and production gaging.—Industrial Tectonics, Inc., 3684 Jackson Rd., Ann Arbor, Mich.

Circle **497** on inquiry card.

Gaging Balls. New 2-page Bulletins 511, 522 and 551 describe and illustrate maker's precision master balls for setting comparator gages and gaging equipment, measuring standards, etc.—Industrial Tectonics, Inc., 3684 Jackson Rd., Ann Arbor, Mich.

Circle **498** on inquiry card.

Gage Blocks. New 4-page illustrated folder describes maker's gage blocks

How's your technical library?

Check this list.

Nuclear Reactors for Industry and Universities, edited by Ernest H. Wakefield, 1954, cloth, 102 pages, 4-page index. Price $2.00 ☐

A Bibliographical Survey of Flow Through Orifices and Parallel-Throated Nozzles by T. H. Redding, 1952, cloth, 207 pages. Price $6.00 ☐

Process Control by A. J. Young, 1954, 140 pages, 3-page index. Price $2.00 ☐

Electronic Circuitry for Instruments and Equipment by Milton H. Aronson, 1953, cloth, 310 pages. Price $4.00 ☐

Scientific and Industrial Glass Blowing and Laboratory Techniques by W. E. Barr and Victor J. Anborn, 1949, 4½" x 8", 388 pages. Price $6.00 ☐

The Electronic Control Handbook by R. R. Batcher & Wm. Moulic, 1952, paper, 244 pages. Price $3.00 ☐

Heat Inertia Problems of Automatic Control of Temperature by Victor Brodia, 1950, paper, 5¼" x 8¼", 61 pages. Price $1.00 ☐

Applications of Industrial pH Controls by Allen L. Chaplin, 1950, cloth, 4½" x 8", 144 pages. Price $2.50 ☐

Maintenance and Servicing of Electrical Instruments by James Spencer, Third Edition 1951, cloth, 4¾" x 8¼", 256 pages. Price $3.00 ☐

Mechanical Measurements by Electrical Methods by Howard C. Roberts, Second Edition 1951, cloth, 4¾" x 8¼", 537 pages. Price $4.00 ☐

Operation and Care of Circular-scale Instruments by James Spencer, 1949, cloth, 4½" x 8", 90 pages. Price $1.50 ☐

Instrumentation for the Process Industries (Sixth Symposium) 1952, paper, 8" x 11¼", 64 pages. Price $2.50 ☐

Instrumentation for the Process Industries (Fifth Symposium) 1951, paper, 8" x 11¼", 56 pages. Price $2.50 ☐

Guide to Foreign Sources of Metallurgical Literature by John T. Milek, 1951, paper, 8½" x 11", 108 pages. Price $2.50 ☐

A Romance in Research—The Life of C. F. Burgess by A. McQueen with Technical Appendix by O. W. Storey, 1951, cloth, 6" x 9", 430 pages. Price $6.00 ☐

Stress Corrosion of Mild Steel by James T. Waber & Hugh J. McDonald, 1947, paper, 5¾" x 8¾", vi+94 pages. Price $2.00 ☐

Instrumentation for the Iron & Steel Industry (Proceedings of Second Conference) 1953, paper 8" x 11¼". Price $2.00 ☐

Instrumentation for the Iron & Steel Industry (Proceedings of First Conference) 1951, paper, 8" x 11¼", 52 pages. Price $2.00 ☐

(Payment must accompany order)

Instruments Publishing Company
845 Ridge Avenue,
Pittsburgh 12, Pennsylvania

Enclosed is $.................. **for** .... **copies of** ....

Name ....

Address ....

City ....

NEW LITERATURE

and accessory sets.—Freeland Gauge Co., 9940 Freeland Ave., Detroit 27, Mich.

Circle **499** on inquiry card.

Hardness Tester. New 4-page illustrated folder describes maker's portable Brinell hardness tester that can be used as bench tester.—Andrew King, 67 E. Lancaster Ave., Ardmore, Pa.

Circle **500** on inquiry card.

X-ray equipment. New 4-page bulletin "Norelco MG 60" describes maker's portable x-ray unit for radiographic and fluoroscopic work.—North American Philips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y.

Circle **501** on inquiry card.

ANALYTICAL

Viscometers. New 12-page descriptive bulletin illustrates maker's rotating-bob-type viscometers for use at extremes of pressure, viscosity and temperature.—Drage Products, 406 32nd St., Union City, N. J.

Circle **502** on inquiry card.

Viscosimeter. New 2-page Bulletin 355 describes maker's "Hoeppler" viscosimeter "Model CH" with temperature range of −35 to +60 C.—Fish-Schurman Corp., 70 Portman Rd., New Rochelle, N. Y.

Circle **503** on inquiry card.

Specific Gravity. New 2-page Bulletin 800 pictures maker's hydrometer-type "Spee/Gee" specific gravity indicator for liquid densities.—Brooks Rotameter Co., Lansdale, Pa.

Circle **504** on inquiry card.

Hg Vapor Detectors. New 2-page bulletin describes maker's line of mercury vapor meters for detecting toxic concentrations of mercury vapor in plant and lab atmospheres.—Harold Kruger Instruments, P. O. Box 164, San Gabriel, Calif.

Circle **505** on inquiry card.

Oxygen Analyzer. New 4-page Bulletin 114 describes and illustrates maker's "Model C" oxygen analyzer for flue-gas analysis, physiological studies, food processing, inert atmospheres, etc.—Arnold O. Beckman, Inc., 1020 Mission St., Pasadena, Calif.

Circle **506** on inquiry card.

Air Pollution. New 4-page bulletin "Beckman Infrared Notes" presents article on use of spectrophotometer and 175-ft air path in smog studies.—Beckman Div., Beckman Instruments, Inc., Fullerton, Calif.

Circle **507** on inquiry card.

Carbon, Sulfur Determination. New 16-page descriptive bulletin presents specifications of maker's two-minute carbon determinator, sulfur determinator, combustion furnaces, oxygen regulator, etc.—Harry W. Dietert Co., 9330 Roselawn Ave., Detroit 4, Mich.

Circle **508** on inquiry card.

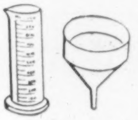
Flame Photometer. New 4-page Bulletin FD63-255 describes and illustrates maker's "Model 146" flame photometer for analysis of alkali metals in solution.—The Perkin-Elmer Corp., Norwalk, Conn.

Circle **509** on inquiry card.

Spectrophotometer. New 6-page Bulletin FD 64-255 describes and illustrates maker's "Model 13-U" universal spectrophotometer, a direct ratio, automatic, recording instrument.—The Perkin-Elmer Corp., Norwalk, Conn.

Circle **510** on inquiry card.

LAB APPARATUS



Laboratory Equipment. New 20-page issue of "Burrell Announcer" No. 55-4-58 describes and illustrates maker's variable-speed shakers, microprojector, dehumidifier, vacuum oven, label varnish, distilled water heater, etc.—Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.

Circle **511** on inquiry card.

Gel-time Meter, Corona. New 4-page Catalog 22 describes and illustrates maker's gel-time meter that automatically measures time required for a fluid thermosetting composition to reach a point of rapid viscosity change during polymerization. 2-page Catalog 17 presents detector that determines corona in high-voltage rotating apparatus.—Sunshine Scientific Instrument, 1810 Grant St., Phila. 15, Pa.

Circle **512** on inquiry card.

Polarimeters. New 2-page descriptive bulletin illustrates maker's microptic polarimeter and saccharimeter for measuring rotations directly by a divided circle, and not through medium of quartz wedges.—Jarrell-Ash Co., 26 Farwell St., Newtonville 60, Mass.

Circle **513** on inquiry card.

Titration Stand. New 2-page Data Sheet 11508 describes maker's "Titra-Lite" titration stand which provides evenly diffused illumination for both titration burettes and flasks.—Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.

Circle **514** on inquiry card.

Lab Equipment. New 4-page Catalog 80-20 describes and illustrates maker's precision-bore glass products.—Fischer & Porter Co., 379 Jacksonville Rd., Hatboro, Pa.

Circle **515** on inquiry card.

Air Permeability Apparatus. New 4-page Bulletin 2262 describes maker's air-permeability apparatus for measuring air permeability of elastomers by diffusion tests.—American Instrument Co., Inc., Silver Spring, Md.

Circle **516** on inquiry card.

Lab Equipment. New 20-page issue of "What's New For The Laboratory" (No. 23) presents distilled-water heaters, bottle fillers, scales, incubators, etc.—Scientific Glass Apparatus Co., Inc., Bloomfield, N. J.

Circle **517** on inquiry card.

Stirrers. New 2-page bulletin describes and illustrates maker's "T-line" direct-drive laboratory stirrers.—Talboys Instrument Corp., 13 Ackerman Ave., Emerson, N. J.

Circle **518** on inquiry card.

When Instruments Must Be Accurate...

The Burlington Meter was chosen for this Bendix-Friez Laboratory Temperature Indicator because they found it met their requirements for an accurate, yet low cost, meter and enabled them to set a desirable price on their instrument. Other famous-name manufacturers have made their selection from the wide ranges, styles and sizes offered by Burlington. Or, let Burlington build a meter to your specifications.

0
2
4
6
8
10
0
10
20
30
40
50
MODEL 741

MODEL 741 SQUARE SEMI-FLUSH

BURLINGTON INSTRUMENT CO.
131 N. Third St., Burlington, Iowa

Burlington
CUSTOM BUILT TO SPECIFICATION

WRITE FOR CATALOG N1

For more information circle **117** on inquiry card.

Tissue Processor. New 4-page bulletin describes and illustrates maker's "Autotechnicon" double-deck and single-deck automatic tissue processors.—The Technicon Co., Chauncey, N. Y.

Circle **519** on inquiry card.

Vacuum Oven. New 2-page bulletin describes maker's small vacuum oven for moisture determinations; and large vacuum oven for low-pressure drying down to one micron.—National Appliance Co., Portland, Ore.

Circle **520** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

Circuit Checker. New 8-page Catalog R-22 describes maker's "Restorer" for detecting and correcting thermocouple circuit faults.—Peerless Electric Co., 1401 W. Market St., Warren, Ohio.

Circle **521** on inquiry card.

Electronic Supplies. New 16-page issue of "This Month" (April-May 1955) presents distributors line of relays, amplifiers, switches, recorders, scintillators, transmitters, compasses, gages, sockets, monitors, barometers, anemometers, timers, tubes, etc.—Herbach & Rademan, Inc., 1204 Arch St., Philadelphia 7, Pa.

Circle **522** on inquiry card.

Coil Tester. New 2-page Catalog 10 describes and illustrates maker's coil tester for instantaneously indicating presence of short-circuited turns or defective insulation in coils.—Sunshine Scientific Instruments, 1810 Grant Ave., Phila. 15, Pa.

Circle **523** on inquiry card.

Power Converter. New 4-page bulletin pictures and describes maker's "Add-A-Phase" power converter for converting single-phase current to three-phase current automatically.—System Analyzer Corp., 700 W. State St., Nokomis, Ill.

Circle **524** on inquiry card.

Inductors. New 2-page Data Sheet EB3(1) presents specifications of maker's fixed and adjustable inductors for a-c bridge measurements at low frequencies.—Leeds & Northrup Co., 4907 Stenton Ave., Philadelphia 44, Pa.

Circle **525** on inquiry card.

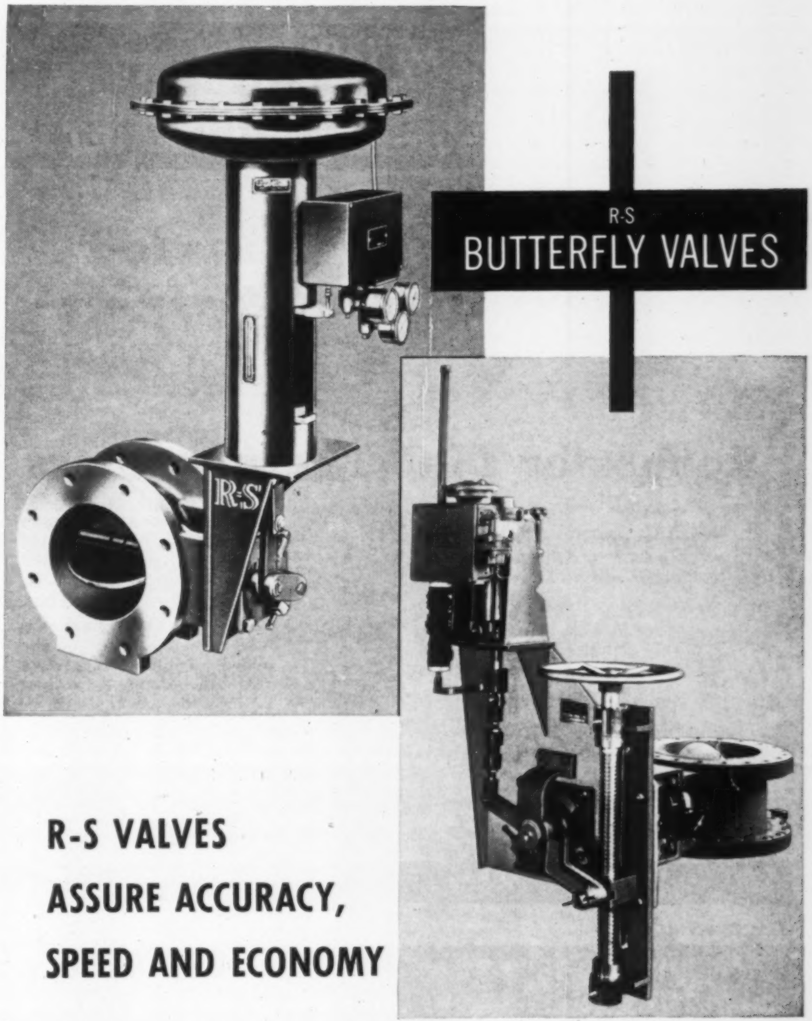
CRO, Accessories. New 8-page illustrated booklet describes maker's low-frequency and high-frequency oscillographs, and accessory instruments—strain-gage controls diff-transformer control, etc.—Allen B. DuMont Labs., Inc., Clifton, N. J.

Circle **526** on inquiry card.

Signal Generator. New 12-page issue of "General Radio Experimenter" (Vol. 29, No. 10) features article on "A Standard Signal Generator for the 900- to 2000-MC Range."—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Circle **527** on inquiry card.

Panel Instruments. New 8-page issue of "Electrical Measurements" (Vol. 21, No. 10) lists maker's com-



R-S VALVES ASSURE ACCURACY, SPEED AND ECONOMY

With automatic controls – R-S Valves will give the most positive and dependable performance obtainable . . .

UNIFORM CONTROL IN ALL POSITIONS . . .
R-S Valves give consistent flow control through all positions in the normal regulating range. The disc simulates a straight line, semi-log characteristic. Cam-driven positioners can furnish other characteristics as required.

REGULATION AND CLOSURE ARE QUICK . . .
Power actuation provides fast or slow regulation-time.

MINIMAL PRESSURE DROP SAVES POWER . . .
In open position the streamlined disc effects less pressure drop than many types of valves. This will show considerable reduction in pumping costs.

S. Morgan Smith offers the best in valve engineering for your control applications. To find the proper valve for any application, or to get additional information on our complete line of butterfly, ball and cone valves, write to the S. Morgan Smith Company, York, Pennsylvania.

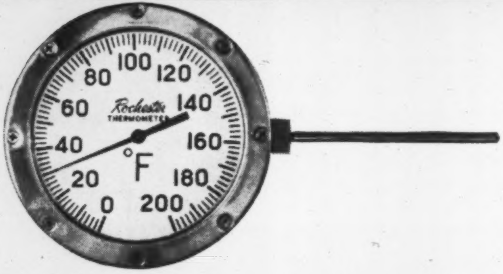
Hydraulic Turbines
Pumps
Gates & Hoists
Trash Rakes
Accessories
HYDRODYNAMICS
Rotovalves
Ball Valves
Butterfly Valves
Free-Discharge Valves
Controllable-Pitch Ship Propellers

SMS
S. MORGAN SMITH CO.

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

For more information circle **118** on inquiry card.

For THERMOMETERS that are DURABLE, ACCURATE, ADJUSTABLE



USE

Rochester Dial Thermometers

Hermetically sealed against moisture and dirt to bring you years of trouble free service.

Designed to be used indoors or out, the stainless steel case is impervious to most corrosive agents.

Recalibrate the dial externally by inserting the stem in liquid of known temperature and adjusting screw attachment.

Rochester Straight-Form Thermometers bring you the added advantage of a stem that can be mounted in any position around the dial.

For additional information contact your Rochester sales engineer or write:

Rochester Manufacturing Company, Inc.
35 Rockwood St., Rochester 10, N. Y.

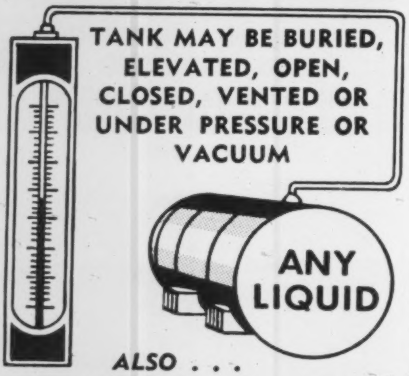
ROCHESTER GAUGES DEPENDABLE ACCURACY

DIAL THERMOMETERS GAUGES AMMETERS

For more information circle **119** on inquiry card.

TANK-O-METER

FOR MEASURING TANK CONTENTS ANY DISTANCE AWAY


TANK MAY BE BURIED, ELEVATED, OPEN, CLOSED, VENTED OR UNDER PRESSURE OR VACUUM
ANY LIQUID

ALSO . . .

HYDROSTATIC GAUGES FOR ALL PURPOSES

PRESSURE • VACUUM • DRAFT
DEPTH & ABSOLUTE PRESSURE
DIFFERENTIAL PRESSURE
MERCURIAL BAROMETERS

SEND FOR BULLETINS

UEHLING INSTRUMENT CO.
470 GETTY AVE., PATERSON, N. J.

For more information circle **120** on inquiry card.

Answers to I.Q. Quiz on page 949

1.—b	5.—c	9.—c
2.—b	6.—d	10.—c
3.—b	7.—a	
4.—b	8.—b	

On the press . . .

The Automatic Factory
—A Critical Examination

by Stephen A. June
John D. Bardis
Lee H. Lurio
Leonard S. Polaner
Oystein Sagedahl
Herbert A. Sklenar
Bernard K. Yenkin

". . . a down-to-earth answer to . . . what is, and what can we expect from the Automatic Factory?"

cloth; 88 pages + viii; 5½ x 8¼"; subject index; illustrations.

$1.50 postpaid

Instruments Publishing Company
845 Ridge Avenue
Pittsburgh 12, Pennsylvania

Enclosed is $............... for............... copies of THE AUTOMATIC FACTORY—A CRITICAL EXAMINATION at $1.50 each, postpaid.

Name ....

Address ....

City ....

NEW LITERATURE

plete line of panel instruments in accuracies as high as 0.25 percent in d-c sensitivities.—Sensitive Research Instrument Corp., Mt. Vernon, N. Y.

Circle **528** on inquiry card.

High-current Test Instruments. New 4-page Data Sheet 455-S describes and illustrates maker's high-current test instruments with applications as variable power sources.—Multi-Amp Corp., 10 Third St., Newark, N. J.

Circle **529** on inquiry card.

TV Alignment. New 8-page Booklet RE 8P describes and illustrates maker's TV alignment equipment, including marker generator, video generator, etc.—Hickok Electrical Instrument Co., 10528 Dupont Ave., Cleveland 8, Ohio.

Circle **530** on inquiry card.

CRO. New 8-page catalog describes and illustrates maker's cathode-ray oscillographs, including types, bandwidths, applications, etc.—Allen B. Du Mont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J.

Circle **531** on inquiry card.

RF Spectrum Analyzer. New 45-page booklet "Handbook of Spectrum Analyzer Techniques" outlines techniques for checking operation of pulse-modulated transmitters, for calibration of cavity wavemeters, etc.—Price 50c.—Polarad Electronics Corp., 43-20 34th St., Long Island City 1, N. Y.

Circle **532** on inquiry card.

Noise Filters. New 4-page Bulletin FS53 describes and illustrates maker's line of R-F noise suppression filters that feature pi-type construction and a metallized-paper dielectric.—Aerovox Corp., New Bedford, Mass.

Circle **533** on inquiry card.

Electronic Test Equipment. New 28-page 1955 Catalog describes maker's high-power impedance meters, variable reactances, bolometers, thermistors, attenuators, couplers, microwave and UHF electronic test equipment.—Narda Corp., 66 Main St., Mineola, L. I., N. Y.

Circle **534** on inquiry card.

Wattmeter. New 2-page bulletin describes and illustrates maker's "Type 28A" wattmeter-bridge for determining RF characteristics of transmission lines, wave traps, etc.—Budelman Radio Corp., 375 Fairfield Ave., Stamford, Conn.

Circle **535** on inquiry card.

Inductance Bridge. New 24-page issue of "Cornell-Dubilier Capacitor" (Vol. 20, No. 4) features article on "Combination Inductance Bridge."—Cornell-Dubilier Electric Corp., Hamilton Blvd., S. Plainfield, N. J.

Circle **536** on inquiry card.

Traveling-wave Amplifier. New 2-Bulletin HA-3B presents electrical and mechanical characteristics of maker's low-power, high-gain traveling-wave-tube amplifier.—Huggins Laboratories, Inc., 711 Hamilton Ave., Menlo Park, Calif.

Circle **537** on inquiry card.

Panel Instruments. New 2-page Bulletin presents specifications of maker's "Series 100" 1-inch sealed, round and square panel instruments.—DeJur Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle **538** on inquiry card.

Precision Voltage Generator. New 4-page Bulletin 2354 pictures and describes maker's "Model A23 Calivolter"—a precision a-c or d-c voltage source for measuring frequency response of amplifiers, recording systems, transformers, etc.—Calidyne Co., Winchester, Mass.

Circle **539** on inquiry card.

Magnetic Amplifiers. New 24-page descriptive booklet presents specifications on maker's magnetic amplifiers, single-phase and three-phase frequency triplers.—American Research and Mfg. Corp., 4914 Del Ray Ave., Bethesda 14, Md.

Circle **540** on inquiry card.

Signal Generator. New 2-page specification sheet describes maker's "Xtalator" VHF signal generator for measurement of gain and sensitivity of VHF components.—Kay Electric Co., 14 Maple Ave., Pine Brook, N. J.

Circle **541** on inquiry card.

Q Measurement. New 2-page bulletin describes maker's "Q-Sweep" for production line Q measurements and "Kilo-Q" low-frequency Q meter.—Kay Electric Co., 14 Maple Ave., Pine Brook, N. J.

Circle **542** on inquiry card.

POTENTIOMETERS

Potentiometers. New 8-page descriptive bulletin illustrates maker's "RL-270" linear and nonlinear potentiometers for generating sine or cosine functions.—Gamewell Co., Newton Upper Falls 64, Mass.

Circle **543** on inquiry card.

Potentiometers. New 2-page Data Sheet 54-51 presents construction, specification and coil characteristics of maker's "Series T" precision potentiometers.—Helipot Corp., 916 Meridian Ave., S. Pasadena, Calif.

Circle **544** on inquiry card.

Turns-counting Dials. New 2-page Data Sheet 54-76 describes maker's "Duodial Series RB" for mounting on ¼-in shafts.—Helipot Corp., 916 Meridian, S. Pasadena, Calif.

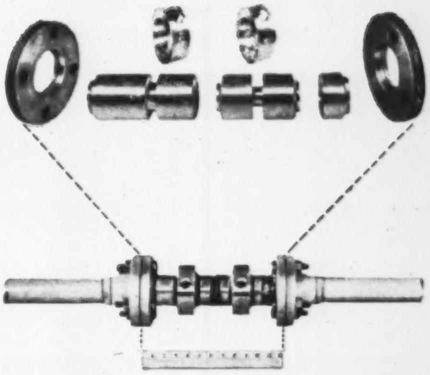
Circle **545** on inquiry card.

SWITCHES, RELAYS

Switches. New 20-page Engineering Bulletin 1057 describes maker's magnetically-operated, glass enclosed, "Glaswitch" sensitive control element for general industrial applications.—Revere Corp. of America, Wallingford, Conn.

Circle **546** on inquiry card.

Relays. New 18-page 1955-56 catalog presents specifications and prices of maker's standard brand relays, aircraft contactors, relay assemblies, ro-



Miniature Venturi Tube Solves Unusual Problem

An important chemical producer looked everywhere . . . couldn't find a ready-made device to measure accurately a corrosive liquid's low flow of 159 lbs. per hour. So he asked the advice of Simplex.

Simplex tailor-made a welded, corrosion-resisting stainless steel Venturi tube. This Venturi tube probably is the smallest in industrial process use. Main diameter is only 0.375"; throat diameter only .105". Machining to .0005" provides specified accuracy.

Consult Simplex on your special measuring problems, large or small. Write to Simplex Valve & Meter Company, Dept. IA-6, 7 E. Orange St., Lancaster, Pa.

SIMPLEX® VALVE AND METER COMPANY

For more information circle **121** on inquiry card.

PYROMETER INSTRUMENT COMPANY

New Plant & Laboratory

Bergenfield 34, New Jersey

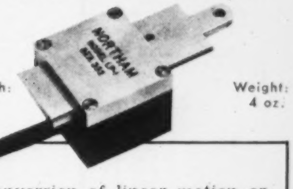
Manufacturers of Pyro Optical, Radiation Immersion and Surface Pyrometers for over 25 years.

The Simplified **PYRO** Optical Pyrometer

PYRO Optical Pyrometer is the only self-contained, direct reading, light-weight and dependable unit for quick and accurate high temperature measurements. Unique construction permits determinations even on MINUTE SPOTS, FAST MOVING OBJECTS or of the SMALLEST STREAMS. Special Foundry Type and Universal Triple Range have an additional Red Scale for direct readings of the true spout and pouring temperatures of molten iron, steel, monel, etc. when measured in the open. Stock ranges from 1400°F to 7500°F or in equivalent Centigrade calibrations. Ask for free Catalog No. 85 for complete details.

Free literature also available on PYRO Surface, Indicating, Radiation and Immersion Pyrometers.

For more information circle **122** on inquiry card.



NORTHAM

LINEAR POSITION TRANSDUCER

Case Length: 1"

Weight: 4 oz.

For conversion of linear motion or position into an electrical output for remote indication, recording, and control. The instrument is of the variable inductance type and provides precise measurements under extremes of acceleration as well as under static conditions. All electrical components are rigidly embedded in the case, permitting operation under shock and vibration conditions.

MODEL LP-1 SPECIFICATIONS:

Range of Motion: . . . . ± ½ in. to ± 2 ins.
Accuracy: . . . . ± 1% full scale
Excitation Frequency: From 60 to 20,000 cps

WRITE FOR BULLETIN NO. IA-1

Northam Engineering Facilities Are Available To Assist You With Any Application Problems.

NORTHAM PRODUCTS INCLUDE . . .

Transducers for pressure, acceleration and displacement measurement and auxiliary electronic equipment for complete systems.

NORTH AMERICAN INSTRUMENTS, INC.

2420 North Lake Avenue • Altadena, Calif.

For more information circle **123** on inquiry card.

Weighing Systems

by Pneumatic Force Balance

PROVIDE AUTOMATION FOR THE CONTINUOUS OR BATCH PROCESS.

A complete line of weight transmitters in single and multiple diaphragm construction with load capacities up to 23,000 pounds per diaphragm. Pneumatic tare balance for any portion of the total load on all models. All moving parts are enclosed totally. Complete weighing systems designed to your requirements.

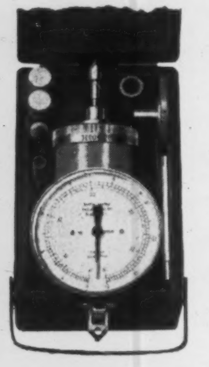
WRITE FOR CATALOG

JOHN R. MONSELL COMPANY
Pitman, N. J.

For more information circle **124** on inquiry card.

Five Range Hand Tachometer

Indispensable in Laboratories, Industrial and Power Plants.



For testing
- Motors
- Turbines
- Engines
- Shaftings
- Etc.

Model A	30—12,000 RPM
Model B	45—18,000 RPM
Model C	60—24,000 RPM
Model D	120—48,000 RPM

Linear speeds in feet per minute can also be measured by using the cut-meter wheel.

Write for circular 106.

Amthor Testing Instrument Co., Inc.
45-53 Van Sinderen Ave.
Brooklyn 7, New York

For more information circle **125** on inquiry card.

Measurements Corporation

MODEL 59 MEGACYCLE METER

The only grid-dip meter covering the wide range of **2.2 Mc. to 400 Mc.**

FREQUENCY CALIBRATION: ±2%

For determining the resonant frequency of tuned circuits, antennas, transmission lines, bypass condensers, chokes, etc. For measuring inductance and capacitance. May also be used as an auxiliary signal generator; for signal tracing and many other applications.

Complete data on request.

MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

For more information circle **126** on inquiry card.

NEW LITERATURE

tary relays, fixed and adjustable timers, etc.—Relay Sales, 4721 W. Madison St., Chicago 44, Ill.

Circle **547** on inquiry card.

Calibrating Relays. New 4-page reprint describes modern technique for performance checks on motor starter overload relays to determine trip times.—Multi-Amp Corp., 10 Third St., Newark 7, N. J.

Circle **548** on inquiry card.

Control Switches. New Technical Bulletin 568 describes and illustrates maker's remote-control switch.—Automatic Switch Co., 391 Lakeside Ave., Orange, N. J.

Circle **549** on inquiry card.

Relays. New 2-page bulletin presents applications and specifications of maker's "Type DC-36" relay for signal circuits, micro-amp switching, etc.—Deltronic Corp., 1507-1509 Riverside Drive, Los Angeles 31, Calif.

Circle **550** on inquiry card.

Switches. New 4-page issue of "Uses Unlimited" (Vol. 9, No. 2) describes and illustrates maker's subminiature snap-action switch for mobile applications.—Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle **551** on inquiry card.

Control Relays. New 2-page bulletin presents line of AEG German-made Auxiliary Relays for rapid application of low-power impulses, for operating circuits simultaneously with one impulse, or for transmitting control impulses over long distances.—Donald C. Seibert, Foot of Christiana Ave., Wilmington, Del.

Circle **552** on inquiry card.

Relay System Tester. New 4-page bulletin describes and illustrates maker's "Model 250F" universal, automatic tester for relay systems in aircraft and guided missiles.—Dit-Mco, Inc., 505 W. 9th St., Kansas City, Mo.

Circle **553** on inquiry card.

Contactors. New 8-page descriptive Bulletin 14B8171A illustrates maker's d-c contactors and control relays for steel mills and heavy industrial applications.—Allis-Chalmers Mfg. Co., 942 S. 70th St., Milwaukee, Wis.

Circle **554** on inquiry card.

CONNECTORS

Hermetic-seal Headers. New 16-page illustrated Booklet 200 describes maker's "Vac-Tite," "All-Glass," and "All-Metal" multi-contact fusion-seal headers for use with hermetically-sealed equipment.—Hermetic Seal Products Co., 29-37 S. Sixth St., Newark 7, N. J.

Circle **555** on inquiry card.

Printed-circuit Connectors. New 2-page Bulletin 42 presents specifications of maker's continental connector "Series PCW22" which accomodates up to 132 solderless wire-wrap connections.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle **556** on inquiry card.

Connectors. New 4-page descriptive folder presents electrical and mechanical specifications of maker's "Series 1300" miniature "AN-type" continental connectors.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle **557** on inquiry card.

Connectors. New 8-page issue of "Amphenol Engineering News" (Vol. 8, No. 2) presents article on "AN Connectors for Potting."—American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.

Circle **558** on inquiry card.

Electrical Connectors. New 12-page Bulletin B59 presents maker's plugs and receptacles for power connecting requirements.—Joy Mfg. Co., Henry W. Oliver Bldg., Pittsburgh 22, Pa.

Circle **559** on inquiry card.

Hermetic-seal Connectors. New 16-page Bulletin GS-5 describes maker's "Canseal" hermetically sealed connectors for aircraft, high temperature installations, etc.—Cannon Electric Co., 3209 Humboldt St., Los Angeles 31, Calif.

Circle **560** on inquiry card.

Subminiature Connector. New 4-page illustrated folder "This is Microdot" covers maker's subminiature connectors.—Microdot Div., Felts Corp., 1826 Fremont Ave., S. Pasadena, Calif.

Circle **561** on inquiry card.

Compression Plugs. New 12-page catalog describes and illustrates maker's octal, loctal, miniature, all-glass, all-metal, etc., "Vac-Tite" compression plugs.—Hermetic Seal Products Co., 29-37 S. Sixth St., Newark 7, N. J.

Circle **562** on inquiry card.

ELECTRONIC COMPONENTS

TV Picture Tubes. New 40-page Bulletin ETD-1001A presents quick-selection guides for television picture tubes.—General Electric Tube Dept., Schenectady 5, N. Y.

Circle **563** on inquiry card.

Electronic Supplies. New 4-page price list presents receiving tubes, TV antennas, coaxial connectors, time switches, adapters, etc.—Lectronic Distributors, 727 Arch St., Philadelphia 6, Pa.

Circle **564** on inquiry card.

Wire, Plugs. New 44-page Catalog 55 describes and illustrates maker's wire, cable, tubing, jacks and plugs, etc.—Birnbach Radio Co., Inc., 145 Hudson St., New York 13, N. Y.

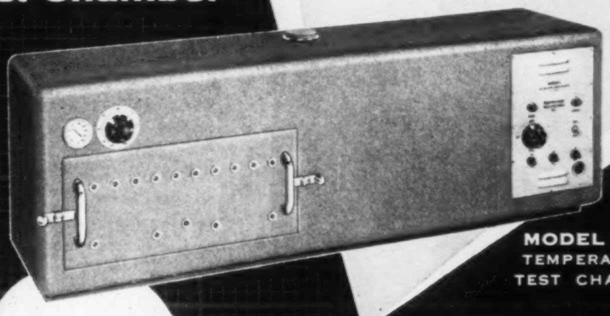
Circle **565** on inquiry card.

Wire, Cable. New 8-page Bulletin SW-1 describes and illustrates maker's microphone cables, sound system cables, intercommunication cables, etc.—Whitney Blake Co., New Haven 14, Conn.

Circle **566** on inquiry card.

Electromagnet. New 2-page bulletin describes and illustrates maker's completely matched 4-inch electromagnet system.—Varian Associates, Palo Alto 2, Calif.

Circle **567** on inquiry card.



Portable...
Versatile...
Temperature Test Chamber

For ambient temperature tests in the LABORATORY or on the PRODUCTION LINE, the Model TC-2 Temperature Test Chamber is ideal. Interchangeable extra test trays may be ordered to eliminate loading delays in continuous production tests, or for convenience in special test work.

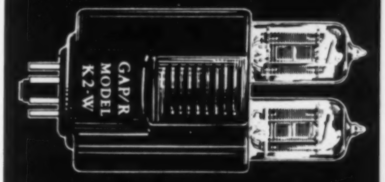
Range: —65° to + 350° F.
Heater: Electric strip heater
Coolant: Dry ice, 15 lbs. capacity
Control: Adjustable thermostat & selectable heat inputs
Load Capacity: 600 cubic inches of test materials
Power: 115V, 5 amp. 50-60 cycle
Overall Size: 48" x 16½" x 12"
Weight: 62½ lbs.

$550.00
F.O.B. LOS ANGELES

MODEL TC-2
TEMPERATURE TEST CHAMBER

STATHAM DEVELOPMENT CORPORATION
12411 W. Olympic Blvd.
Los Angeles 64, Calif.

For more information circle **127** on inquiry card.



GAP/R
Operational Amplifier

This universal building-block is unrivalled for Analog Computing. Our price of twenty dollars is the result of volume production. Features balanced inputs, wide band, high gain, *plus* maximum efficiency.

Write for literature on companion plug-ins for DC stabilization, and for extended ranges of voltage and power.

Immediate shipment,
postpaid in U.S.A.

George A. Philbrick Researches, Inc.
230 Congress Street, Boston 10, Massachusetts

For more information circle **128** on inquiry card.

High Precision OPTICAL COMPONENTS Any Size For Astronomical and Physical Research

•

Parabolic, Spherical, Ellipsoidal and Plane MIRRORS

•

Plane Parallel PLATES

•

SCHLIEREN SYSTEMS

•

Wind Tunnel OPTICS

•

LENSES & PRISMS of Glass Natural or Synthetic CRYSTALS

•

Complete Optical and Mechanical INSTRUMENTS

•

Made to Specifications

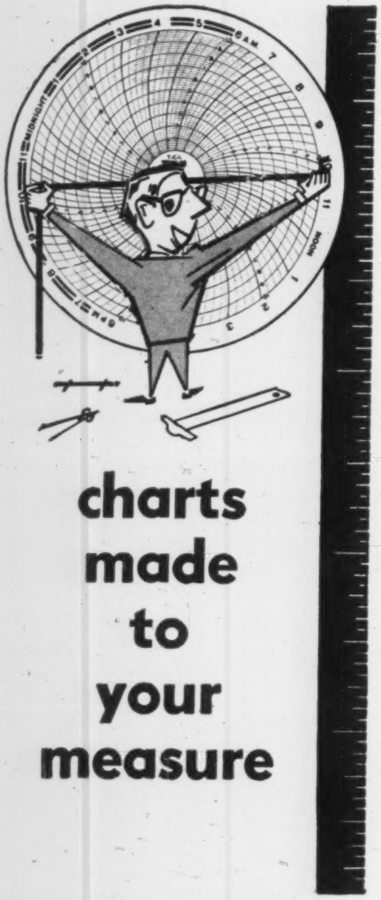
•

High Vacuum Coating

•

John Unertl Optical Co
3551-3555 East Street
Pittsburgh 14, Penna.

For more information circle **129** on inquiry card.


charts made to your measure

When you need "Special" recording charts . . . for measurements under unusual conditions, or for new instruments . . . call on Technical's chart specialists.

Technical will design and manufacture your charts using the same highly developed techniques employed in producing their supply of over 8000 standard chart items. Plates will be made from accurately etched wax engravings, charts will be printed on machines using the latest in electronic control of registration, and special paper will be selected to give you the recording results you require. Among Technical's "special" users are the National Bureau of Standards, Bell Aircraft Corp., E. I. Du Pont de Nemours & Co., Inc. and others.

To help you in planning for the right chart to fit your "Special" needs, Technical offers a bulletin with basic chart information for your file. Ask for your copy of "Technical Notes".

Serving America's Foremost Industries

TCI

TECHNICAL CHARTS, INC.

188 VAN RENSSELAER STREET
BUFFALO 10, NEW YORK
Nationally Represented by
TECHNICAL SALES CORP.
16599 Meyers Road Detroit 35, Michigan

For more information circle **130** on inquiry card.

Over 85% of the torque wrenches used in industry are

Sturtevant

TORQUE WRENCHES

Read by Sight, Sound or Feel.

- Permanently Accurate
- Practically Indestructible
- Faster—Easier to use
- Automatic Release
- All Capacities

in inch grams...inch ounces,..inch pounds ...foot pounds (All sizes from 0-6000 ft. lbs.)

Every manufacturer, design and production man should have this valuable data. Sent upon request.

P. A. STURTEVANT CO
ADDISON QUALITY ILLINOIS

For more information circle **131** on inquiry card.

STANDCO
FREQUENCY METER
100-130 VOLTS
395
400
405
CYCLES
PER SECOND
H.H. STICHT CO INC
NEW YORK NY

"STANDCO"

VIBRATING REED
FREQUENCY METERS

ACCURACY ±.5%

RUGGED—DEPENDABLE

Normal Frequencies:
25, 50, 60 or 400 cycles
Special Ranges:
from 15-1500 cycles

AVAILABLE IN FOLLOWING TYPES:

PANEL MOUNTING: 3½" flush bakelite, metal or hermetically sealed cases
Meet all MIL specs.

SWITCHBOARD MOUNTING: 7¼" round surface, or 4½" square semi-flush cases

PORTABLES: In large or small cases

Write for Bulletin 805

HERMAN H. STICHT CO., INC.
27 PARK PLACE NEW YORK, N. Y.

For more information circle **132** on inquiry card.

NEW LITERATURE

Capacitors. New 12-page Bulletin 5410 describes and illustrates maker's capacitors, printed circuits, filters and resistors.—Aerovox Corp., New Bedford, Mass.

Circle **568** on inquiry card.

Capacitors. New 2-page Bulletin 530 describes maker's sintered-anode tantalum electrolytic capacitors for d-c circuits having low a-c ripple content.—Cornell-Dubilier Electric Corp., S. Plainfield, N. J.

Circle **569** on inquiry card.

Pulse Transformers. New 2-page data sheet describes maker's "PT-10FB2" pulse transformers for developing triggers up to 2-microsecond pulse width.—Valor Electronic Components Co., 5808 Marilyn Ave., Culver City, Calif.

Circle **570** on inquiry card.

Current Transformers. New 4-page Bulletin 365-1 describes and illustrates maker's donut-type current transformers.—Associated Research, Inc., 3758 Belmont Ave., Chicago 18, Ill.

Circle **571** on inquiry card.

MECHANICAL COMPONENTS

Diaphragms. New 16-page Catalog B.F. 150 describes various classes of maker's long-stroke, deep convolution diaphragms.—Bellofram Corp., 144 Moody St., Waltham 54, Mass.

Circle **572** on inquiry card.

Custom Parts. New 4-page Bulletin KEM 3M 1054 describes and illustrates maker's custom-made parts and assemblies, including gears, cams, etc.—R. S. Wilder, Inc., 26 Bedford St., Waltham 54, Mass.

Circle **573** on inquiry card.

Thrust Retainers, Washers. New 4-page bulletin describes and illustrates maker's thrust retainers and washers, including selection, uses, applications, installations, lubrication, etc.—Hartford Steel Ball Co., Inc., West Hartford, Conn.

Circle **574** on inquiry card.

Ball Bearings. New 4-page issues of "MPB Engineering News" (Vol. 1, Nos. 1, 2 and 3) feature articles, charts, graphs and engineering drawings on proper applications of miniature ball bearings.—Miniature Precision Bearings, Inc., Keene, N. H.

Circle **575** on inquiry card.

Radial Bearings. New 4-page specification sheet covers maker's retainer radial bearings.—New Hampshire Ball Bearings, Inc., Peterborough, N. H.

Circle **576** on inquiry card.

Roller Drives. New 4-page Bulletin 105A presents dimensions and load ratings of maker's high-speed precision indexing roller drives.—Ferguson Machine & Tool Co., P. O. Box 191, St. Louis 21, Mo.

Circle **577** on inquiry card.

Fasteners. New 8-page Bulletin P87A covers style and size data on maker's stainless fasteners such as screws, bolts, nuts, rivets, etc.—Allmetal Screw Products Co., Inc., 821 Stewart Ave., Garden City, L. I., N. Y.

Circle **578** on inquiry card.

Vibration Mounts. New 8-page Catalog AB-35 describes maker's complete line of vibration and shock mounts.—T. R. Finn & Co., Inc., 200 Central Ave., Hawthorne, N. J.

Circle **579** on inquiry card.

Vibration Control. New 4-page Bulletin K4A presents engineering specifications and performance data on maker's vibration, shock and noise control products.—Korfund Co., Inc., 48-355 32nd Place, Long Island City 1, N. Y.

Circle **580** on inquiry card.

Air Line Lubricator. New 4-page bulletin describes and illustrates maker's air line lubricator that handles up to ½-in. pipe size.—Gits Bros. Mfg. Co., 1866 S. Kilbourn Ave., Chicago 23, Ill.

Circle **581** on inquiry card.

Aluminum Grating. New 16-page Bulletin 2486 describes types, sizes and load characteristics of maker's electro forged steel and interlocked aluminum grating.—Blaw-Knox Equipment Div., Blaw-Knox Co., Pittsburgh 38, Pa.

Circle **582** on inquiry card.

Wiring Duct. New 2-page descriptive bulletin illustrates maker's wiring duct for holding, protecting and distributing a harness.—Taylor Electric, Inc., 15400 Dale, Detroit 23, Mich.

Circle **583** on inquiry card.

Electronic, Electromechanical Equipment. New 8-page illustrated folder describes development and production facilities for precision electromechanical and electronic equipment.—Pitometer Log Corp., 237 Lafayette St., New York 12, N. Y.

Circle **584** on inquiry card.

Shelving, Storage Bins. New 40-page Catalog 481 presents line of steel shelving, parts bins, drawer units, etc.—Equipto, Aurora, Ill.

Circle **585** on inquiry card.

Lock Nuts. New 16-page Booklet 580 describes maker's lock nuts and fasteners for radio, television and electronic assemblies.—Palnut Co., Irvington 11, N. J.

Circle **586** on inquiry card.

Metal Boxes. New 28-page 1955 Catalog 5 describes and illustrates over one thousand sizes of maker's drawn-metal boxes.—Zero Mfg. Co., P. O. Box 509E, Burbank, Calif.

Circle **587** on inquiry card.

MATERIALS

Electrical Laminations. New 40-page Catalog L-355 describes and illustrates maker's special, standard and "MIL-T" electrical laminations.—Thomas & Skinner Steel Products Co., Inc., Indianapolis, Ind.

Circle **538** on inquiry card.

Laminated Plastic. New 18-page Catalog D-55 describes maker's "Dilecto" laminated plastic available in glass base, fabric base, paper base, asbestos base, etc.—Continental-Diamond Fibre Co., Newark, Del.

Circle **589** on inquiry card.

Silica Tubes, Vessels. New 4-page bulletin describes and illustrates maker's fused-silica "Rotosil" tubing and vessels.—Amersil Co., Inc., 685 Ramsey Ave., Hillside 5, N. J.

Circle **590** on inquiry card.

ALINA

KNURL CUTTERS

ALINA KNURL CUTTERS actually mill the pattern and produce chips in the process. Alina Knurl Cutters will cut your machining time approx. 30%. They will provide the solution to some of your most complex knurling problems.

DESIGNED TO

- knurl all machineable materials
- knurl thin-walled parts without internal support
- maintain fine diametral limits
- knurl diameters from 1/16" to 10 ft.

Models available for all types of machines. For detailed information and prices, write to

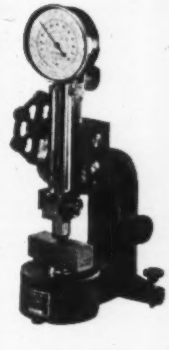
ALINA CORPORATION • 401 Broadway, New York 13, N. Y.

For more information circle **133** on inquiry card.

HARDNESS TESTING...

done WITH NO MENTAL HAZARDS. The SCLEROSCOPE has done it for the past 50 years.

In general use for specification purposes. Simple, sturdy Comparatively inexpensive.



Illustrated bulletins free

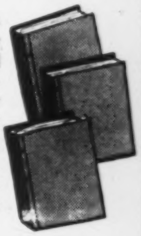
The Shore Instrument & Mfg. Co., Inc.

90-35 Van Wyck Expressway
Jamaica 35, N. Y.

For more information circle **134** on inquiry card.

ENGINEERS

Save your firm thousands of dollars in searching for data on ELECTRONIC TEST EQUIPMENT.



In these DATA SHEETS you have comprehensive and descriptive Data easily accessible for comparison, current and packed with vital working information. Now available to industry for the first time.

- Order your copy of a three volume set containing illustrated descriptive data sheets on 870 items procured for use by the U. S. Air Force.
- Contains 2400 (8-1/2 x 11") pages, recently brought up-to-date, mounted in 3 post expandable hard back binders.
- Price $100 per set plus postage while supply lasts. Orders accompanied by check filled as received with postage paid. Free sample Data Sheet with further details furnished on request.

CARL L. FREDERICK
AND ASSOCIATES
Bethesda 14, Maryland

For more information circle **135** on inquiry card.

SEARCHLITE SECTION

CLASSIFIED ADVERTISING
EMPLOYMENT & BUSINESS OPPORTUNITIES

The advertising rate is $12.00 per inch for all advertising (An advertising inch is measured 7/8 inch vertically by 2 1/6 inches wide.)

Send advertisements to INSTRUMENTS & AUTOMATION, 845 Ridge Ave., Pittsburgh 12, Pa.

Address box replies to Instruments Publishing Co., 845 Ridge Ave, Pittsburgh 12, Pa.

PRECISION
OPTICS

Manufactured to closest tolerances . . . Large or small runs.

LENSES . .
PRISMS . .
WINDOWS . .
MIRRORS . .
FLATS . .
ASSEMBLIES

HIGH VACUUM COATINGS
Our engineering department is available for consultation. Send us your problem. Estimates promptly submitted.

ZENITH
OPTICAL LABORATORY
COPIAGUE, L. I., N. Y.

For more information circle **136** on inquiry card.

ASK FOR BULLETIN NO. 1

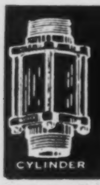
Toroidal Winder

REX RHEOSTAT
COMPANY
BALDWIN, L. I. N. Y.
Telephone BAldwin 3-5160

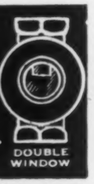
For more information circle **137** on inquiry card.

Opening For SUPERVISORY ENGINEER

Supervisory Engineer, E. E. or M. E. background, wanted by leading commercial instrument manufacturer to plan, coordinate and administer work of drafting department and test laboratory. Previous experience in precision small parts design and manufacture desirable. Location—Western New York State. Good salary plus other emoluments, including profit sharing, group insurance, etc. Excellent opportunity for the right man. Replies held in strictest confidence. Write c/o Box 296.



FLOW INDICATORS
All sizes up to 6"
SEND FOR CATALOG
ERNST
Water Column & Gage Co.
LIVINGSTON, N. J.



For more information circle **138** on inquiry card.

*SALES???

Instrumentation and Electronic lines wanted by manufacturers' Agency with Southern California following in Aircraft, Guided Missile and Military Circles.

R. W. HODGSON CO.
Technical Sales Representation & Research & Development Engineering
3406 W. Washington Blvd. L. A. 18, Calif.
REpublic 2-2651

INSTRUMENT TECHNICIAN FOR NEW ZEALAND

N. Z. Forest Products Ltd., Kinleith, Tokoroa, North Island, New Zealand, require an Instrument Technician with experience in maintaining and installing industrial instrumentation and automatic process control equipment, electrical and pneumatic. Salary commensurate with experience and qualifications. House available. Removal expenses paid. Applications with full particulars of qualifications and experience, with references, should be addressed to:—

Personnel Officer
N. Z. FOREST PRODUCTS LTD.,
P. O. Box 14,
Tokoroa,
New Zealand

MECHANICAL ENGINEER

For large precious metals concern located in northern New Jersey.

We desire a machine designer for development of light precision equipment involving cams and indexing mechanisms.

20 years experience in the instrument field preferred. M E degree desired but not essential.

Reply with complete resume stating age, experience, education, and salary desired to Box 295.

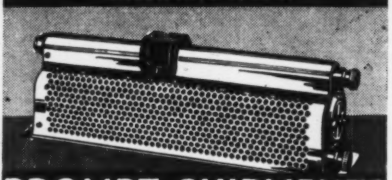
PLASTIC BOXES

Our list of 63 sizes and types of plastic boxes will be sent upon request. Ideal for storage of small parts and merchandising.

SCHRADER INSTRUMENT CO.
East Main Street • Independence, Iowa

For more information circle **140** on inquiry card.

REX RHEOSTAT CO.
BALDWIN, L. I., N. Y.



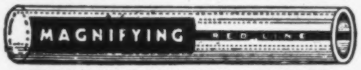
PROMPT SHIPMENTS
WRITE FOR NEW CATALOG

For more information circle **141** on inquiry card.

INSTRUMENT DEVELOPMENT ENGINEER

Large chemical industrial concern has opening at Louisville, Kentucky, for an outstanding instrument engineer with a B.S. or M.S. degree in chemical, mechanical or electrical engineering. Prefer a few years' industrial experience. Work involves sufficient knowledge of instruments and their operation to select and apply these instruments to the measurement and control of various chemical processes. Candidate should have sufficient knowledge to modify available instruments to meet special application. Salary and opportunity above average. Reply should include age, education, experience, salary requirement and address. Reply to: Box 291.

GAGE GLASSES AND
High Pressure Rubber Gaskets
ALL SIZES TO FIT YOUR GAGES & VALVES



ERNST WATER COLUMN & GAGE CO.
Send for Catalog **LIVINGSTON, N. J.**

For more information circle **143** on inquiry card.

GAUGE & INSTRUMENT CONTROLLED AUTOMATION

Your present machines can be equipped with full automation, including automatic loading and gauge feedback control of size.
SPECIALISTS IN CENTERLESS GRINDER AUTOMATION.

Jessup Eng. & Dev. Co. **"JEDCO"** 3980 Superior Ave. Cincinnati 36, Ohio

For more information circle **144** on inquiry card.

C.O.M.S.I.P.

Specialized in control Engineering
Instrument layout—Procurement—Application—conventional and graphic panel design and construction
INSTALLATION—REVAMPING
STARTING UP—MAINTENANCE
40 Ave. Verdun • Croissy • S&O France

For more information circle **145** on inquiry card.

OPPORTUNITIES FOR ENGINEERS IN THE INDUSTRIAL ADVERTISING AND TECHNICAL WRITING FIELD are today almost unlimited. If you are under 35 years old, like to write, have a technical background, and want a career in industrial advertising, we have an opening for you in the advertising department of a well-known instrument company that offers big opportunities. Ability to write and salesmindedness are essential. Write to us. We will give you more details. Box 294.

SALES ENGINEERS—We have openings for Sales Engineers in Detroit, Cleveland, New York, and St. Louis. We manufacture industrial instruments and have a complete line of Mechanical and Electronic Recorder Controllers. Our resources are second largest in the industrial instrument field and Management is desirous of expanding sales. Excellent opportunities for graduates in Electrical, Mechanical, and Chemical Engineering. Box 292.

Felts. New 20-page technical brochure "Design Book" describes uses of felt for friction qualities, cushioning, filtering, insulating, etc.—Felters Co., 210 South St., Boston 11, Mass.

Circle **591** on inquiry card.

Powder Metallurgy. New 52-page Engineering Manual E-55 presents case histories pertinent for both actual and potential users of metal powder parts.—Chrysler Corp., Amplex Div., Detroit 31, Mich.

Circle **592** on inquiry card.

Stainless-steel Wire. New 32-page Booklet ADV166 describes "Austenitic, Ferritic, and Martensitic" classifications of maker's "Rezistal" stainless steel wire, giving common uses and typical end products.—Crucible Steel Co. of America, P. O. Box 88, Pittsburgh 30, Pa.

Circle **593** on inquiry card.

Filter Paper. New 2-page bulletin describes and illustrates maker's "Hank" brand filter paper.—Jacoby-Tarbox Corp., 808 Nepperhan Ave., Yonkers, N. Y.

Circle **594** on inquiry card.

Wire, Ribbon. New 12-page booklet describes maker's facilities for manufacture of fine wire and ribbon, wire and ribbon parts, and small parts plating.—Sylvania Electric Products, Inc., 1100 Main St., Buffalo 9, N. Y.

Circle **595** on inquiry card.

Vulcanized Fibre, Laminated Plastic. New 16-page bulletin "Engineering Materials for Modern Industry" presents maker's vulcanized fibre and "Phenolite" laminated plastic.—National Vulcanized Fibre Co., 1055 Beech St., Wilmington 99, Del.

Circle **596** on inquiry card.

Aluminum. New 16-page "Aluminum Bulletin" (Spring 1955) features articles on various applications of aluminum.—Aluminum Association, 420 Lexington Ave., New York 17, N. Y.

Circle **597** on inquiry card.

Corrosion-resistant Alloy. New 4-page Bulletin B122 describes maker's "A-286 Superalloy"—a nonmagnetic, corrosion-resistant, heat-resistant material.—Allegheny Ludlum Steel Corp., Pittsburgh 22, Pa.

Circle **598** on inquiry card.

WANTED

Manufacturers Representatives:

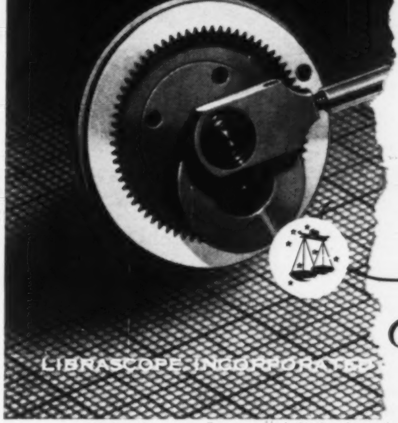
Industrial Instrument Corporation of Odessa, Texas desires competent representative on exclusive territory basis for complete line of bellows type mercuryless flow meters, pressure tight bearings, orifice plates and other accessories. Write giving full details of organization and territory desired to:

W. G. HARDY, Sales Manager
P. O. Drawer 152,
Odessa, Texas

Manufacturers Representative

Engineer desires newly manufactured electronic and electro-mechanical products for sale to Guided Missile and Aircraft Companies located in Southern California. Reply to:

LEE GRANT SNYDER CO.
Technical Sales & Contract Administrators
1418 N. Highland Ave.,
Hollywood 28, California
Phone Hollywood 9-6278



SINE-COSINE MECHANISM

INSTANTANEOUS—ACCURATE PRECISION ANGLE RESOLVER FOR ANALOG COMPUTERS

Librascope's Sine-Cosine mechanism is a precision analog computer element for converting angular rotational movements into linear sine or cosine movements. Designed for problems of changing variables involving vector components, range and bearing computations, flight computations and many other trigonometric functions. *Write for detailed catalog information.*

SPECIFICATIONS:

Positive pre-set indexing
(3 position 90° apart)
Mounting: Conventional, 3 lug
Tolerances: zeros through
2 holes within .001 in.
Stroke .750 ± .0015"
each side zero
Accuracy: 0.2% full scale
Weight: 2 oz.

Computers and Controls

LIBRASCOPE

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

1607 FLOWER ST., GLENDALE, CALIF.

For more information circle **146** on inquiry card.

ELECTRONICS

easy to teach ... easy to learn

with the New, Low Cost

Crow Basic Electronics Kit Model 50-A

for INDUSTRIAL TRAINING or HOME STUDY

• Here's the ideal instruction aid for your employee training program—a combination of equipment and text material designed to let you learn electronics by *visual experiment.*

The kit contains 82 precision components, everything you need to perform 60 experiments. A correlated, 275-page work manual shows you in words and pictures exactly how to proceed.

Model 50-A complements Crow Electri-Kit Model 41-B . . . takes you from Beginners' Electricity directly into the study of Electronics. With this unique kit, anyone familiar with basic electrical principles can learn electronics easily. It can even be used for self instruction at home . . . as fascinating as your favorite hobby.

60 OPERATING ASSEMBLIES

Capacitors • Voltage Dividers • Vibrators
Frequency Discriminators and Multipliers
Filters • Electrical Indicating Instruments
Rectifiers • Resonant Circuits • many more

Model 50-A Kit provides a solid foundation for further training in specialized electronic fields—Radio Transmitting and Receiving, Industrial Electronic Circuitry, or Radar and Television Circuitry.

These principles are covered in the Crow Electronic Tubes, Circuits and Devices Kit (Model 53) available soon.

Price of the complete, 82-piece Model 50-A kit—including precision meter (±1%), resistors, coils, capacitor bank, etc.—is $87.50. Write for illustrated folder giving full details.

CROW ELECTRI-CRAFT CORP.

Division of Universal Scientific Co., Inc.
Box 336W, Vincennes, Indiana

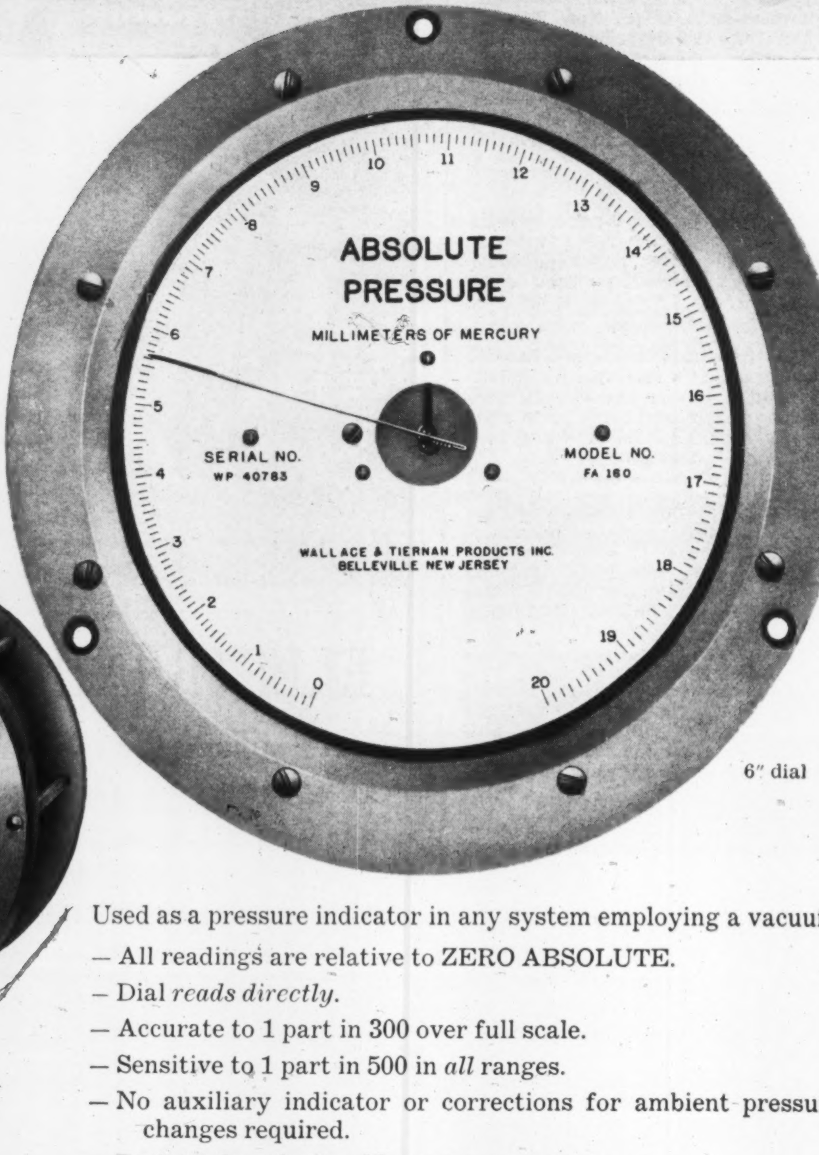
For more information circle **147** on inquiry card.

ABSOLUTE PRESSURE INDICATOR

. . . FOR DEEP VACUUM WORK

Measures *pressure*
directly from
ZERO ABSOLUTE
to atmospheric

. . . swiftly and precisely



ABSOLUTE PRESSURE
MILLIMETERS OF MERCURY
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
SERIAL NO. WP 40783
MODEL NO. FA 160
WALLACE & TIERNAN PRODUCTS INC.
BELLEVILLE NEW JERSEY

6″ dial

ABSOLUTE PRESSURE
0 2 4 6 8 10 12 14 16 18 20
MM MERCURY

2¾″ dial

TYPE FA-160

Used as a pressure indicator in any system employing a vacuum.

- All readings are relative to ZERO ABSOLUTE.
- Dial *reads directly.*
- Accurate to 1 part in 300 over full scale.
- Sensitive to 1 part in 500 in *all* ranges.
- No auxiliary indicator or corrections for ambient pressure changes required.
- Protected against sudden pressure surges.
- Ranges:

Ranges:	0.1– 20mm Hg.	0–200mm Hg.
	0 – 50mm Hg.	0–410mm Hg.
	0 –100mm Hg.	390–800mm Hg.

- Dial Sizes: All ranges in either 2¾″ or 6″ dia.

For additional information on W&T Absolute Pressure Indicators, write today for Publication No. TP-28-A.

WALLACE & TIERNAN
INCORPORATED
PRECISION INSTRUMENTS AND ELECTRICAL MECHANISMS
25 MAIN ST., BELLEVILLE 9, N. J.
In Canada: Wallace & Tiernan, Ltd., Toronto

A-102

For more information circle **33** on inquiry card.

Advertisers' Index . . .

INSTRUMENTS and AUTOMATION

A

A'G'A Division of Elastic Stop Nut Corp. of America 997
Aircraft-Marine Products, Inc. 875
Alina Corporation 1013
American Chain & Cable Co. 905
American Meter Company 907
American Phenolic Corporation 898
Amthor Testing Instrument Co., Inc. 1010
Automatic Electric Sales Corporation 939
Automatic Switch Co. 881
Automatic Temperature Control Co., Inc. 994

B

Bailey Meter Company 937
Baker & Company, Inc. 924
Baldwin-Lima-Hamilton Corp. 901
Barber-Colman Company 921, 923
Barber-Colman Company, Wheelco Instruments Division 919
Barksdale Valves 878
Beckman, Inc., Arnold O. 902
Black, Sivalls & Bryson, Inc. ..... Inside Front Cover
Bourns Laboratories 920
Bristol Company 866-867
Brown Instruments Division of Minneapolis-Honeywell Regulator Co. 862, 928-929
Bruno-New York Industries Corporation 949
Brush Electronics Company 855-856
Burlington Instrument Co. 1006
Burroughs Corporation, Electronic Instruments Division 904

C

Cannon Electric Co. 847
Chace Co., W. M. 906
Clare & Co., C. P. 863
Commercial Research Laboratories, Inc. 860
C.O.M.S.I.P. (Instrument Control Consultant) 1014
Conoflow Corporation 915
Consolidated Engineering Corporation 852-853, 887, 913, 944, 948, 999
Cramer Co., Inc., R. W. 998
Crescent Insulated Wire & Cable Co. 884
Crow Electri-Craft Corp. 1015

D

Dale Products, Inc. 917
DeJur-Amsco Corporation 941
Dialight Corporation 942
Diamond Power Specialty Corp. 918
Doelcam, Division of Minneapolis-Honeywell Regulator Co. 883

E

Eagle Signal Corporation 916

Continued on page 1018

Instruments and Automation

brings you more than 2,000 pages of instrumentation data.
The regular subscription price is $4.00, BUT:

On two or more new subscriptions or renewals sent together on one order the rates will be reduced as follows:

2 separate one-year subscriptions	$ 6.00
3 separate one-year subscriptions	7.50
4 separate one-year subscriptions	9.00
5 separate one-year subscriptions	10.00

Offer good only in U. S. and Canada.

Use This Subscription Card ➧

INSTRUMENTS PUBLISHING CO.
845 Ridge Avenue, Pittsburgh 12, Pa.

Please enter the following subscriptions and bill me (Company) at ....

Signed ....
Address ....

Name .... Position ....
Company ....
Products Manufactured ....
Address ....

Name .... Position ....
Company ....
Products Manufactured ....
Address ....

Name .... Position ....
Company ....
Products Manufactured ....
Address ....

Name .... Position ....
Company ....
Products Manufactured ....
Address ....

For additional names use another sheet

Inquiry Card ➧

For further details concerning developments reported in advertisements, New Product or New Literature reviews, CIRCLE THE NUMBER corresponding to that which appears with the ad or write-up.
When indicating change of address, kindly note old address.

please fill in COMPLETELY:

Name .... **Title** ....
Company ....
Products Manufactured ....
Company Address .... **City** .... **Zone** .... **State** ....

Instruments and Automation
June '55
Good until 9-1-55

Advertised Products

1	21	41	61	81	101	121	141
2	22	42	62	82	102	122	142
3	23	43	63	83	103	123	143
4	24	44	64	84	104	124	144
5	25	45	65	85	105	125	145
6	26	46	66	86	106	126	146
7	27	47	67	87	107	127	147
8	28	48	68	88	108	128	148
9	29	49	69	89	109	129	
10	30	50	70	90	110	130	
11	31	51	71	91	111	131	
12	32	52	72	92	112	132	
13	33	53	73	93	113	133	
14	34	54	74	94	114	134	
15	35	55	75	95	115	135	
16	36	56	76	96	116	136	
17	37	57	77	97	117	137	
18	38	58	78	98	118	138	
19	39	59	79	99	119	139	
20	40	60	80	100	120	140	

New Instruments

201	221	241	261	281	301	321	341	361	381
202	222	242	262	282	302	322	342	362	382
203	223	243	263	283	303	323	343	363	383
204	224	244	264	284	304	324	344	364	384
205	225	245	265	285	305	325	345	365.	
206	226	246	266	286	306	326	346	366	
207	227	247	267	287	307	327	347	367	
208	228	248	268	288	308	328	348	368	
209	229	249	269	289	309	329	349	369	
210	230	250	270	290	310	330	350	370	
211	231	251	271	291	311	331	351	371	
212	232	252	272	292	312	332	352	372	
213	233	253	273	293	313	333	353	373	
214	234	254	274	294	314	334	354	374	
215	235	255	275	295	315	335	355	375	
216	236	256	276	296	316	336	356	376	
217	237	257	277	297	317	337	357	377	
218	238	258	278	298	318	338	358	378	
219	239	259	279	299	319	339	359	379	
220	240	260	280	300	320	340	360	380	

New Literature

401	421	441	461	481	501	521	541	561	581
402	422	442	462	482	502	522	542	562	582
403	423	443	463	483	503	523	543	563	583
404	424	444	464	484	504	524	544	564	584
405	425	445	465	485	505	525	545	565	585
406	426	446	466	486	506	526	546	566	586
407	427	447	467	487	507	527	547	567	587
408	428	448	468	488	508	528	548	568	588
409	429	449	469	489	509	529	549	569	599
410	430	450	470	490	510	530	550	570	590
411	431	451	471	491	511	531	551	571	591
412	432	452	472	492	512	532	552	572	592
413	433	453	473	493	513	533	553	573	593
414	434	454	474	494	514	534	554	574	594
415	435	455	475	495	515	535	555	575	595
416	436	456	476	496	516	536	556	576	596
417	437	457	477	497	517	537	557	577	597
418	438	458	478	498	518	538	558	578	598
419	439	459	479	499	519	539	559	579	
420	440	460	480	500	520	540	560	580	

☐ **Check for address change. Show OLD address here:** ....

ADVERTISERS' INDEX

Continued from page 1017

Electrical & Physical Instrument Corporation 943
Electronic Associates, Inc. 950
Emery Company, A. H. 912
Eppley Laboratory, Inc. 874
Ernst Water Column & Gage Co. 1014
ESC Corporation 956
Exact Weight Scale Company 987

F

Falstrom Company 848
Farris Flexible Valve Corporation 870-871
Fenwal Incorporated 868
Fielden Instrument Division 903
Fisher Governor Company 909
Ford Instrument Company 938
Foxboro Company 857
Frederick and Associates, Carl L. 1013

G

General Electric Company 850-851
General Electric Company, X-Ray Department 879
Genisco Incorporated 932
Gordon Co., Claud S. 930
Green Instrument Company 995

H

Hammel-Dahl Company Back Cover
Hathaway Instrument Company 922
Hays Corporation 869
Heise Bourdon Tube Company, Inc. 945
Helicoid Gage Division 905
Hewlett-Packard Company 911
Hodgson Co., R. W. 1014
Hughes Research & Development Laboratories 926

I

Illinois Testing Laboratories, Inc. 996
Industrial Instrument Corp. 876, 940, 1015
Industrol Corporation 944
Instruments Publishing Co. Inside Back Cover
International Radiant Corp. 936
International Rectifier Corporation 999

J

Jessup Engineering and Development Company (Instrument Control Consultant) 1014
Johnson Engineering Company, Inc., Welton V. 996
Joy Manufacturing Company 848

K

Kearfott Company, Inc. 947
Klipfel Valves, Inc. 882
Kollmorgen Optical Corporation 1004
Kollsman Instrument Corporation 889

L

Leeds & Northrup Co. 892
Leslie Co. 886
Levin & Son, Inc., Louis 998
Lewis Engineering Co. 858
Librascope, Incorporated 1015
Littleford Bros., Inc. 946
Logan Engineering Co. 994

M

MacKenzie Walton Co. 997
Mallory & Co., Inc., P. R. 931
Manning, Maxwell & Moore, Inc. 864-865, 890-891
Marsh Instrument Co. 999
Marshalltown Manufacturing Co. 923
Measurements Corporation 1010
Metalsalts Corporation 942
Midwestern Instruments 872
Minneapolis-Honeywell Regulator Co., Industrial Division 862, 928-929
Moeller Instrument Company 861
Monsell Company, John R. 1010

N

Nash Engineering Company 888
New Zealand Forest Products Ltd. 1014
North American Instruments, Inc. 1009

O

Offner Electronics Inc. 933

P

Palmer Thermometers, Inc. 1002
Panellit, Inc. 1003
Permag Corp. 946
Philbrick Researches, Inc., George A. 1011
Potter Instrument Company, Inc. 995
Pritchard & Co. of California, J. F. 935
Production Instrument Co. 993
Pyrometer Instrument Company 1009

R

Radiation, Inc. 885
Reeves Instrument Corporation 877
Republic Aviation 996
Rex Rheostat Co. 1014
Richard Rimbach Associates 854
Rochester Manufacturing Company, Inc. 1008

S

Scherr Optical Tools, Inc. 997
Schrader Instrument Co. 1014
Schutte and Koerting Company 897
Servospeed Div. of Electro Devices, Inc. 917
Shallcross Manufacturing Co. 1001
Shore Instrument & Mfg. Co., Inc. 1013
Simplex Valve & Meter Co., Inc. 1009
Smith Co., S. Morgan 1007
Snyder Co., Lee Grant 1015
Sprague Engineering Corporation 994
Statham Development Corporation 1011
Statham Laboratories 899
Sticht Co., Inc., Herman H. 1012
Streeter-Amet Co. 998
Sturtevant Co., P. A. 1012
Swartwout Company 925

T

Technical Charts, Inc. 1012
Technology Instrument Corp. 934

U

Uehling Instrument Co. 1008
Unertl Optical Co., John 1011
Universal General Corp. 944

V

Veeder-Root Incorporated 927

W

Wallace & Tiernan Incorporated 1016
Wheelco Instruments Division, Barber-Colman Company 919
Winzeler Manufacturing & Tool Co. 995

Z

Zenith Optical Laboratory 1014

FIRST CLASS
PERMIT No. 1441
(Sec. 34.9 P.L.&R.)
PITTSBURGH, PA.

BUSINESS REPLY CARD

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

3c POSTAGE WILL BE PAID BY—

INSTRUMENTS PUBLISHING CO.
845 Ridge Avenue
Pittsburgh 12, Pa.

FIRST CLASS
PERMIT No. 1441
(Sec. 34.9 P.L.&R.)
PITTSBURGH, PA.

BUSINESS REPLY CARD

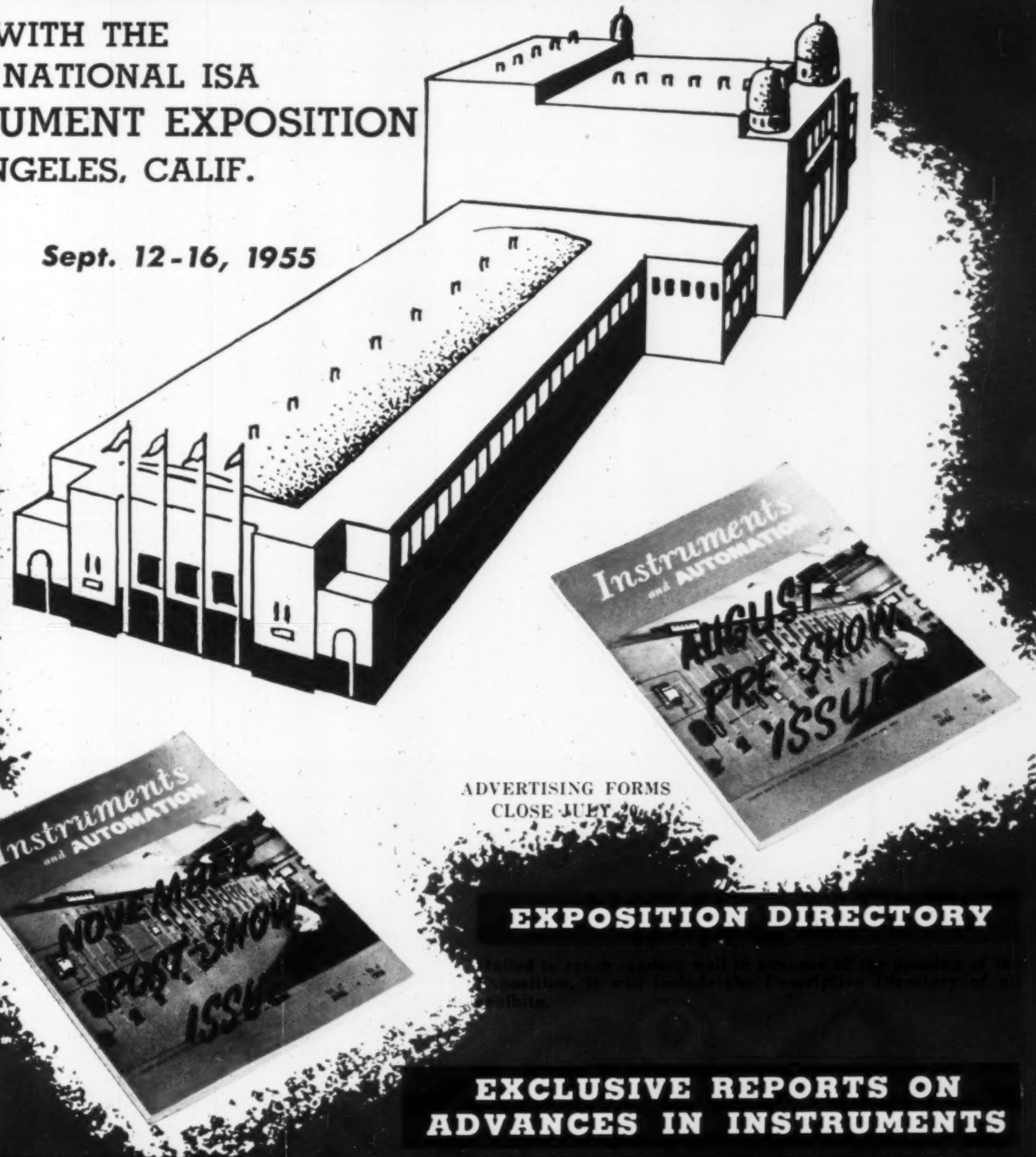
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

3c POSTAGE WILL BE PAID BY—

INSTRUMENTS PUBLISHING CO.
845 Ridge Avenue
Pittsburgh 12, Pa.

TIE-IN WITH THE
TENTH NATIONAL ISA
INSTRUMENT EXPOSITION
LOS ANGELES, CALIF.

Sept. 12-16, 1955



ADVERTISING FORMS
CLOSE JULY 20

EXPOSITION DIRECTORY

Mailed to reach readers well in advance of the opening of the Exposition. It will include the Descriptive Directory of all exhibits.

ADVERTISING FORMS CLOSE
OCTOBER 20

EXCLUSIVE REPORTS ON ADVANCES IN INSTRUMENTS

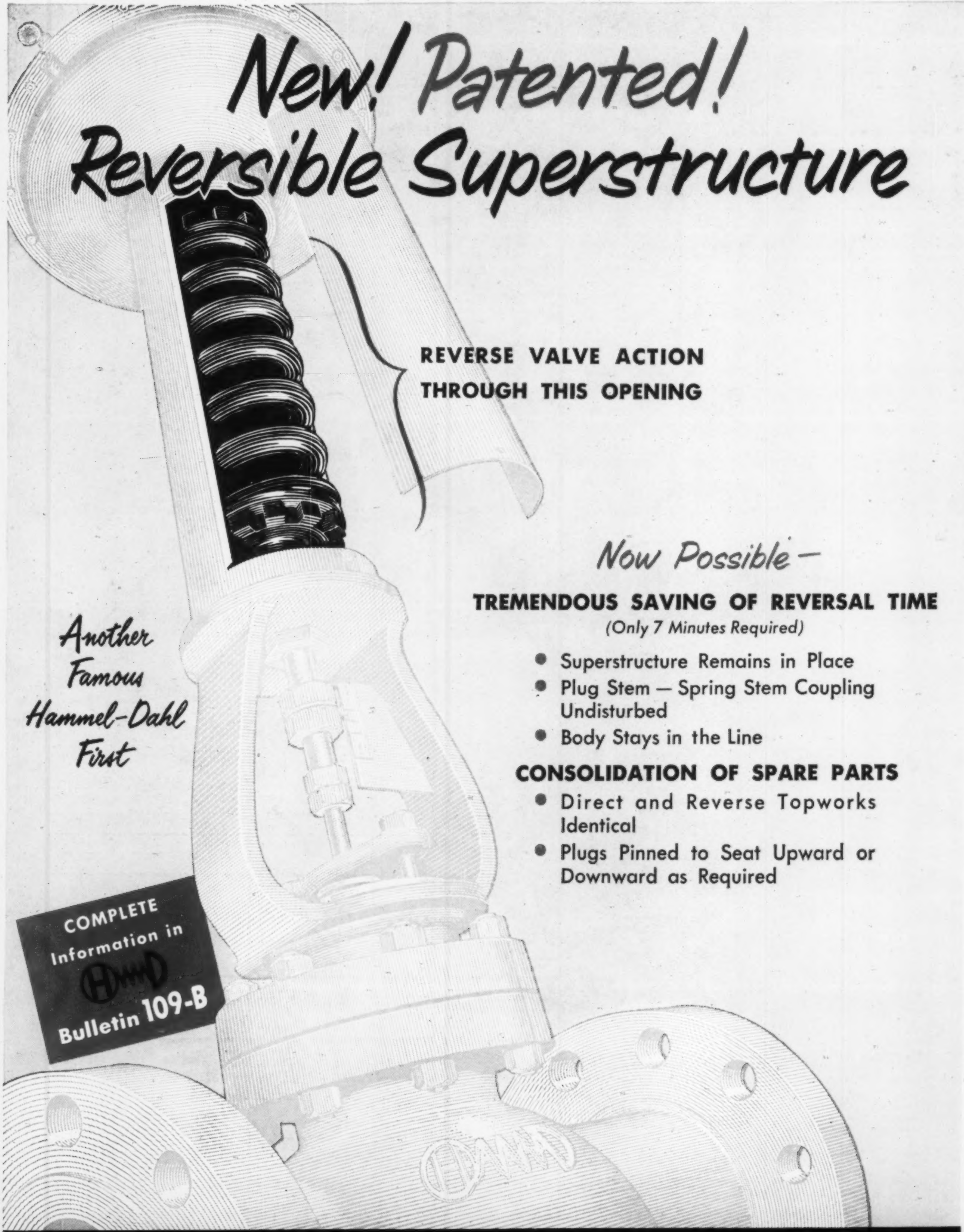
and laboratory devices for measurement, analysis, inspection, testing, computing and automatic control; and the illustrated story of the Instrument Exposition—plus all regular features.

Instruments *and* AUTOMATION

845 RIDGE AVE., PITTSBURGH 12, PA. — FAIRFAX 1-9161

Representatives: M. D. Pugh, Altadena, Calif.; Harold Short, Boston; Harold W. Haskell, Chicago 1; Harold W. Haskell, Cincinnati 5; James H. Wright, St. Louis 1, Mo.; Richard Rimbach, Jr., New York 17; Robert H. Maxwell, Philadelphia; C. Goldsamp, Pittsburgh 12; Edward F. Wright, Dallas, Texas; John G. N. Hughes, London, W. 1, England.

For more information circle **116** on inquiry card.



New! Patented! Reversible Superstructure

REVERSE VALVE ACTION
THROUGH THIS OPENING

Another Famous Hammel-Dahl First

COMPLETE
Information in
Bulletin 109-B

Now Possible—

TREMENDOUS SAVING OF REVERSAL TIME

(Only 7 Minutes Required)

- Superstructure Remains in Place
- Plug Stem — Spring Stem Coupling Undisturbed
- Body Stays in the Line

CONSOLIDATION OF SPARE PARTS

- Direct and Reverse Topworks Identical
- Plugs Pinned to Seat Upward or Downward as Required

HAMMEL-DAHL COMPANY

175 POST ROAD, (WARWICK) PROVIDENCE 5, R. I., U. S. A.
SALES OFFICES IN ALL PRINCIPAL CITIES
MANUFACTURING PLANTS IN WARWICK, R. I., U. S. A., CANADA, ENGLAND, FRANCE AND HOLLAND
CANADIAN MANUFACTURING AFFILIATE—GUELPH ENGINEERING CO., GUELPH, ONT.

For more information circle **102** on inquiry card.